Supplementary Online Content

Kim H, Meath THA, Tran FW, Quiñones AR, McConnell KJ, Ibrahim SA. Association of Medicare mandatory bundled payment system for hip and knee joint replacement with racial/ethnic difference in joint replacement care. *JAMA Netw Open*. 2020;3(9):e2014475. doi:10.1001/jamanetworkopen.2020.14475

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This supplementary material has been provided by the authors to give readers additional information about their work.
Notes: We identified hospitals participating in BPCI model 1, phase 2 of model 2 or 4 and post-acute care providers participating in BPCI model 3 for joint replacements based on BPCI participant list on the CMS website. We excluded hospitals and post-acute providers from our sample if they ever participated in BPCI models I, phase 2 of model II, model III, and phase 2 of model IV at least once during our study period.
## eTable 1. Definition of outcomes and explanatory variables

| Definition                                                                 | Data source                                                                 |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| **Primary outcomes in the main analysis (Table 2-4)**                     |                                                                             |
| Total spending                                                            | Standardized, inflation-adjusted Medicare payments that occurred during episode of care (i.e. index LEJR inpatient hospitalization and 90 day post-discharge period) except payments to durable equipment and hospice care | Medicare 100% claims |
| Discharge to institutional post-acute care                                | A binary variable that indicates whether a patient was discharged to institutional post-acute settings (inpatient rehabilitation facility, skilled nursing facility, swing bed, and long-term care hospital) | Home Health Agency, Inpatient, and Skilled Nursing Facility Claims |
| Relevant readmission                                                      | A binary variable that indicates whether a patient was readmitted to a hospital within 90 day post-discharge period. We excluded irrelevant readmissions based on CMS definition. | Inpatient Claims and list of MS-DRG and ICD diagnosis codes from CMS¹ |
| **Secondary outcomes in the main analysis (Table 2-4)**                  |                                                                             |
| Standardized, inflation-adjusted spending                                  | We reported all Medicare-allowed payment amounts in 2016 dollars. We also standardized payment amounts by removing Medicare payment variation caused by differences in wage-index, special payments related to medical education, or disproportionate share hospital status.² |
| Index hospitalization                                                     | Medicare payments for index inpatient hospitalization.                      | Inpatient Claims |
| Relevant readmission                                                      | Medicare payments for relevant readmissions, as defined by CMS, within 90 day post-discharge period. | Inpatient Claims and list of MS-DRG and ICD diagnosis codes from CMS¹ |
| Institutional post-acute care                                            | Medicare payments for total institutional post-acute care (skilled nursing facility, inpatient rehab, long-term care hospital, and swing bed) within 90 day post-discharge period | Skilled Nursing Facility and Inpatient Claims |
| Skilled nursing facility                                                  | Medicare payments for skilled nursing facility use within 90 day post-discharge period. | Skilled Nursing Facility Claims |
| Inpatient rehabilitation facility                                         | Medicare payments for inpatient rehabilitation use within 90 day post-discharge period. | Inpatient Claims |
| Long-term care hospital                                                  | Medicare payments for long-term care use within 90 day post-discharge period. | Inpatient Claims |
| Swing bed                                                                | Medicare payments for swing bed care use within 90 day post-discharge period. | Skilled Nursing Facility Claims |
| Home health agency                                                        | Medicare payments for home health care use within 90 day post-discharge period | Home Health Agency Claims |
| Outpatient facility                                                       | Medicare payments for outpatient care use within 90 day post-discharge period. | Outpatient Claims |
| Professional services                                                     | Medicare payments for non-institutional care (e.g. non-institutional physician services) within 90 day post-discharge period. | Medicare Part B Carrier Claims |
| **Health service use**                                                   |                                                                             |
| Discharge to home health care                                            | A binary variable that indicates whether a patient was discharged to home health care. | Home Health Agency Claims |
| **Discharge to home** | A binary variable that indicates whether a patient was discharged to home without any paid care. | **Home Health Agency, Inpatient, and Skilled Nursing Facility Claims** |
|-----------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| **Mean length of stay, Institutional post-acute care facility (days)** | Numbers of institutional post-acute care stay days within 90 day post-discharge period. | **Skilled Nursing Facility and Inpatient Claims** |
| **Mean length of stay, Index hospitalization (days)** | Numbers of index hospitalization stay days | **Inpatient Claims** |

**Quality of care**

| Post-discharge complications | A binary variable that indicates whether a patient had any complications within 90 day post-discharge period. We constructed a composite measure of complications that include the occurrence of heart attack, pneumonia, sepsis, surgical site bleeding, pulmonary embolism, mechanical complications, or periprosthetic joint/wound infection following joint replacement. This measure has been modified from NQF #1550 to use our study population as a denominator. | **Inpatient and Outpatient Claims and list of MS-DRG and ICD diagnosis codes from NQF³** |
| 90-day emergency department use | A binary variable that indicates whether a patient visited an emergency department within 90 day post-discharge period. | **Inpatient and Outpatient Claims and list of MS-DRG and ICD diagnosis codes from CMS¹** |
| 90-day mortality | A binary variable that indicates whether a patient died during care episode (that includes the index inpatient stay and 90 day post-discharge period). | **Inpatient and Outpatient Claims and Master Beneficiary Summary File** |

**Explanatory variables in the main analysis (Table 2-4)**

**Key explanatory variables**

| Race/Ethnicity measure | Binary variables that indicates whether a beneficiary was white, black, or Hispanic, with whites as the reference group. | **Master Beneficiary Summary File** |
| Treatment MSA measure | A binary variable that indicates whether each hip/knee joint replacement was initiated in one of the MSAs participating in CJR. | **Medicare 100% claims and list of hospitals participating in CJR** |
| Post-CJR period measure | A binary variable that indicates whether each hip/knee joint replacement occurred after the implementation of CJR | **Inpatient Claims** |

**Other explanatory variables**

| Surgery-level | Binary variables that indicate whether a surgery was hip fracture, elective knee, or elective hip replacement surgery based on CMS definition and ICD-9/-10 codes | **Inpatient Claims, CJR Final Rule, and ICD diagnosis codes from CMS¹** |
| Types of surgery | | |
| Presence of major complications or comorbidities during hospital stay | A binary variable that indicates whether a patient had any major complications or comorbidities during the hospital stay (MS 469 vs MS 470) | **Inpatient Claims** |
| Patient-level | | |
|                                   | Description                                                                 | Source                                                                 |
|-----------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------|
| **Age**                           | Binary dummy variables that indicate whether a patient's age was 66-70, 71-75, 76-80, and 81 or above. | Master Beneficiary Summary File                                      |
| **Female**                        | A binary variable that indicates whether a patient was female.               | Master Beneficiary Summary File                                      |
| **Binary measure of each hospital**| Binary dummy variables that indicate the hospital where hip/knee joint replacements occurred | Inpatient Claims                                                     |
| **Binary measure of each year**   | Binary dummy variables that indicate the year when hip/knee joint replacements occurred | Inpatient Claims                                                     |
| **Binary measure of each quarter**| Binary dummy variables that indicate the quarter when hip/knee joint replacements occurred | Inpatient Claims                                                     |
| **Hospital-level variables in the descriptive analysis and models with propensity score weighting (Table 1)** |                                                                 |                                                                     |
| **Major teaching hospital**       | Binary variable for hospitals with membership in the Council of Teaching Hospitals of the Association of American Medical Colleges. | CMS Provider of Services Files                                      |
| **Safety-net hospital**           | Binary variable of safety-net hospital status. Safety net hospitals were defined as those in the top decile of disproportionate share hospital index. | CMS Provider of Services Files                                      |
| **Ownership type**                | Binary variable of hospital ownership type. Non-profit hospitals included those who reported being owned by private non-profits, churches, and other. Public hospitals included those who reported being owned by local, state, or federal government, tribal groups, and hospital districts. This variable was missing for 1% of the hospitals in this study. | CMS Provider of Services Files                                      |
| **Volume of Medicare joint replacements** | The number of joint replacement discharges from the hospital during the study period. Joint replacement discharges were identified by applying eligibility criteria from the CJR final rule (CMS, 2015). Low, medium, and high categories were created by breaking volume into tertiles. | Inpatient Claims                                                     |
| **Mean operating margin**         | Continuous measure of operating margin, calculated as the ratio of patient-care-related income to patient-care-related revenue | Healthcare Cost Report Information System                            |
eTable 2. Outcomes trends between treatment and control MSAs for white, black, and Hispanic patients during the pre-CJ period.

|                          | 2014                          | 2015                          |
|--------------------------|-------------------------------|-------------------------------|
|                          | Estimate | 95% CI          | Estimate | 95% CI          |
| **White patients**       |          |                 |          |                 |
| Primary outcomes         |          |                 |          |                 |
| Total spending ($)       | 109      | [-150, 368]     | 52       | [-236, 339]     |
| Discharge to institutional post-acute care (%) | 0.2      | [-1.2, 1.6]     | 0.0      | [-1.8, 1.9]     |
| 90-day readmission (%)   | 0.1      | [-0.6, 0.8]     | 0.3      | [-0.5, 1.1]     |
| **Secondary outcomes**   |          |                 |          |                 |
| Standardized spending ($) |          |                 |          |                 |
| Index hospitalization    | 9        | [-44, 63]       | -15      | [-67, 36]       |
| Readmission              | 45       | [-34, 123]      | 15       | [-85, 114]      |
| Institutional post-acute care | 59      | [-140, 258]     | 162      | [-76, 400]      |
| Long-term care hospital  | 28       | [-3, 59]        | 33       | [-11, 78]       |
| Inpatient rehabilitation | -17      | [-151, 118]     | 32       | [-128, 191]     |
| Skilled nursing facility | 51       | [-116, 217]     | 66       | [-113, 244]     |
| Home health              | -15      | [-67, 38]       | -32      | [-111, 46]      |
| Swing bed                | -3       | [-47, 41]       | 31       | [-36, 99]       |
| Outpatient service       | -8       | [-25, 8]        | -5       | [-29, 19]       |
| Physician service        | 31       | [-21, 82]       | -7       | [-73, 58]       |
| **Health Service Use**   |          |                 |          |                 |
| Discharge to home health (%) | -0.1     | [-1.9, 1.6]     | -0.6     | [-3.3, 2.1]     |
| Discharge to home (%)    | -0.1     | [-1.5, 1.4]     | 0.5      | [-1.8, 2.9]     |
| Days in institutional post-acute care | 0.2      | [-0.2, 0.5]     | 0.2      | [-0.2, 0.6]     |
| Days in hospital         | 0.0      | [0.0, 0.0]      | 0.0      | [-0.1, 0.0]     |
| Quality of Care (%)      |          |                 |          |                 |
| Complication             | 0.0      | [-0.3, 0.2]     | -0.3     | [-0.6, 0.1]     |
| 90-day ED visit          | 0.2      | [-0.4, 0.8]     | -0.1     | [-0.8, 0.6]     |
| 90-day mortality         | 0.1      | [-0.2, 0.3]     | 0.0      | [-0.3, 0.3]     |

|                          | 2014                          | 2015                          |
|--------------------------|-------------------------------|-------------------------------|
|                          | Estimate | 95% CI          | Estimate | 95% CI          |
| **Black patients**       |          |                 |          |                 |
| Primary outcomes         |          |                 |          |                 |
| Total spending ($)       | -256     | [-1,179, 667]   | 152      | [-889, 1,192]   |
| Discharge to institutional post-acute care (%) | -2.1     | [-5.8, 1.6]     | 0.2      | [-4.4, 4.8]     |
| 90-day readmission (%)   | -1.9     | [-4.9, 1.1]     | -1.9     | [-5.1, 1.3]     |
| Secondary outcomes                  | Standardized spending ($) |  |  |
|------------------------------------|---------------------------|---|---|
| Index hospitalization              | 43 [-97, 183]             | 49 [-104, 202] |
| Readmission                        | -349 [-791, 93]           | -53 [-517, 412] |
| Institutional post-acute care      | -238 [-1,056, 579]        | -362 [-1,298, 573] |
| Long-term care hospital            | 22 [-203, 246]            | 18 [-199, 235] |
| Inpatient rehabilitation           | -474 [-1,088, 139]        | -625 [-1,296, 46] |
| Skilled nursing facility           | 310 [-262, 881]           | 438 [-247, 1,123] |
| Home health                        | -26 [-155, 102]           | -1 [-184, 182] |
| Swing bed                          | -95 [-316, 126]           | -194 [-462, 75] |
| Outpatient service                 | -85 [-171, 2]             | -36 [-153, 82] |
| Physician service                  | -54 [-186, 77]            | -52 [-204, 100] |
| **Health Service Use**             |                           |               |
| Discharge to home health (%)       | 1.2 [-2.2, 4.5]           | 0.0 [-4.4, 4.3] |
| Discharge to home (%)              | 1.0 [-1.8, 3.7]           | -0.2 [-3.7, 3.3] |
| Days in institutional post-acute care | 0.3 [-1.1, 1.6]          | -0.1 [-1.5, 1.3] |
| Days in hospital                   | 0.0 [-0.1, 0.1]           | 0.0 [-0.2, 0.2] |
| **Quality of Care (%)**            |                           |               |
| Complication                       | 0.0 [-1.0, 1.0]           | 0.4 [-1.0, 1.9] |
| 90-day ED visit                    | 1.6 [-1.4, 4.6]           | 2.2 [-0.7, 5.1] |
| 90-day mortality                   | 0.6 [-0.5, 1.6]           | 0.6 [-0.5, 1.7] |
| **Hispanic patients**              |                           |               |
| **Primary outcomes**               |                           |               |
| Total spending ($)                 | 206 [-526, 939]           | -734 [-1,791, 322] |
| Discharge to institutional post-acute care (%) | 3.3 [-1.2, 7.8] | -1.7 [-6.5, 3.1] |
| 90-day readmission (%)             | 0.2 [-2.6, 3.0]           | 1.2 [-2.7, 5.1] |
| **Secondary outcomes**             |                           |               |
| Standardized spending ($)          |                           |               |
| Index hospitalization              | -23 [-173, 127]           | -115 [-403, 174] |
| Readmission                        | 186 [-342, 713]           | -117 [-647, 413] |
| Institutional post-acute care      | 290 [-376, 957]           | 166 [-645, 977] |
| Long-term care hospital            | 183 [-26, 392]            | 194 [-54, 442] |
| Inpatient rehabilitation           | 143 [-296, 583]           | 593 [-79, 1,265] |

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|                                    |      |       |      |       |
|------------------------------------|------|-------|------|-------|
| Skilled nursing facility           | -19  | [-518, 481] | -677 | [-1,382, 28] |
| Home health                        | 60   | [-60, 179] | 57   | [-123, 238] |
| Swing bed                          | -17  | [-119, 85] | 56   | [-88, 200] |
| Outpatient service                 | -36  | [-137, 65] | -44  | [-161, 72] |
| Physician service                  | 56   | [-115, 228] | 105  | [-67, 278] |
| **Health Service Use**             |      |       |      |       |
| Discharge to home health<sup>a</sup> (%) | 0.0  | [-4.2, 4.2] | 5.7  | [0.9, 10.6] |
| Discharge to home<sup>a</sup> (%)   | -3.3 | [-6.1, -0.6] | -4.0 | [-8.0, -0.1] |
| Days in institutional post-acute care | 0.0  | [-1.0, 1.0] | -0.8 | [-2.2, 0.7] |
| Days in hospital                   | 0.1  | [-0.1, 0.2] | 0.1  | [-0.1, 0.3] |
| **Quality of Care (%)**            |      |       |      |       |
| Complication                       | 0.2  | [-1.1, 1.6] | -0.8 | [-2.8, 1.3] |
| 90-day ED visit                    | 0.5  | [-2.3, 3.2] | -2.4 | [-5.5, 0.8] |
| 90-day mortality                   | -0.2 | [-1.6, 1.2] | -1.1 | [-2.8, 0.6] |

<sup>a</sup> Outcome violates parallel pre-trend assumption
### eTable 3. Changes in secondary outcomes under CJR across White, Black, and Hispanic patients (N=747,098)

| | CJR Hospitals | | Non-CJR Hospitals | | CJR vs. Non-CJR Hospitals |
|---|---|---|---|---|---|---|
| | (1) Pre-CJR | (2) Post-CJR | (3) Difference | (4) Pre-CJR | (5) Post-CJR | (6) Difference | (7) Change associated with CJR | (8) 95% CI | (9) P-value |
| **White patients** | | | | | | | | | |
| Standardized spending ($) | | | | | | | | | |
| Index hospitalization | 13,229 | 12,449 | -780 | 13,132 | 132,401 | -731 | -19 | [-65, 27] | 0.421 |
| Readmission | 1382 | 1291 | -92 | 1,264 | 1,207 | -56 | -30 | [-89, 29] | 0.313 |
| Institutional post-acute care | 6149 | 4255 | -1,894 | 5,941 | 4,501 | -1,439 | -450 | [-792, -107] | 0.010 |
| Long-term care hospital | 89 | 48 | -41 | 110 | 63 | -47 | 4 | [-30, 38] | 0.830 |
| Inpatient rehabilitation | 1,282 | 793 | -489 | 1,450 | 1,040 | -410 | -82 | [-381, 216] | 0.587 |
| Skilled nursing facility | 4,548 | 3,239 | -1,309 | 4,093 | 3,154 | -939 | -347 | [-580, -113] | 0.004 |
| Home health | 2,023 | 1,965 | -58 | 1,986 | 1,951 | -35 | -3 | [-149, 143] | 0.969 |
| Swing bed | 230 | 176 | -54 | 288 | 244 | -44 | -24 | [-70, 22] | 0.303 |
| Outpatient service | 516 | 639 | 123 | 538 | 653 | 116 | 10 | [-15, 34] | 0.433 |
| Physician service | 3,335 | 3,185 | -151 | 3,313 | 3,186 | -127 | -26 | [-80, 28] | 0.348 |
| **Health Service Use** | | | | | | | | | |
| Discharge to home health (%) | 37.4 | 42.7 | 5.3 | 35.2 | 38.3 | 3.2 | 2.4 | [-1.9, 6.6] | 0.272 |
| Discharge to home (%) | 16.4 | 23.9 | 7.5 | 19.4 | 26.7 | 7.3 | 0.2 | [-3.3, 3.7] | 0.914 |
| Days in institutional post-acute care | 11.8 | 8.1 | -3.7 | 10.8 | 8.2 | -2.7 | -1.0 | [-1.5, -0.4] | 0.000 |
| Days in hospital | 4.3 | 3.8 | -0.6 | 4.2 | 3.7 | -0.5 | 0.0 | [-0.1, 0.0] | 0.356 |
| **Quality of Care (%)** | | | | | | | | | |
| Complication | 4.4 | 3.4 | -1.0 | 3.9 | 3.0 | -0.9 | 0.1 | [-0.2, 0.3] | 0.644 |
| 90-day ED visit | 15.0 | 18.9 | 3.9 | 14.6 | 18.5 | 3.9 | 0.1 | [-0.4, 0.6] | 0.763 |
| 90-day mortality | 2.9 | 2.4 | -0.5 | 2.5 | 2.1 | -0.4 | 0.0 | [-0.1, 0.2] | 0.951 |
| **Black patients** | | | | | | | | | |
| Standardized spending ($) | | | | | | | | | |
| Index hospitalization | 13,309 | 12,563 | -746 | 13,203 | 12,568 | -635 | -55 | [-160, 50] | 0.300 |
| Readmission | 1,632 | 1,784 | 152 | 1,681 | 1,618 | -64 | 156 | [-175, 488] | 0.354 |
| Institutional post-acute care | 8,530 | 5,938 | -2,592 | 7,952 | 6,246 | -1,706 | -1162 | [-1,873, -452] | 0.001 |
| Long-term care hospital | 176 | 106 | -69 | 289 | 230 | -58 | -9 | [-154, 137] | 0.904 |

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| Service                        | Std. Spends ($) Mean (95% CI) | Quality (%) Mean (95% CI) |
|-------------------------------|-------------------------------|--------------------------|
| Inpatient rehabilitation      | 1,987 (1,167 - 2,020)         | 31.0 (9.3 - 43.4)        |
| Skilled nursing facility      | 6,249 (4,529 - 7,969)         | 9.5 (6.3 - 12.6)         |
| Home health                   | 2,273 (2,223 - 2,323)         | 15.9 (11.1 - 19.7)       |
| Swing bed                     | 118 (136 - 75)                | 18.3 (23.3 - 4.6)        |
| Outpatient service            | 593 (753 - 160)               | 4.7 (4.2 - 0.5)          |
| Physician service             | 3,426 (3,296 - 131)           | 2.3 (2.1 - 0.3)          |

**Health Service Use**

| Measure                             | Std. Spends ($) Mean (95% CI) | Quality (%) Mean (95% CI) |
|-------------------------------------|-------------------------------|--------------------------|
| Discharge to home (%)               | 31.0 (9.3 - 43.4)             | 6.2 (0.8, 11.5)          |
| Discharge to home (%)               | 9.5 (6.3 - 12.6)              | -0.2 [-4.4, 4.1]         |
| Days in institutional post-acute care | 15.9 (11.1 - 19.7)          | 14.4 (10.7 - 3.7)        |
| Days in hospital                    | 4.7 (4.2 - 0.5)               | 4.5 (3.9 - 0.6)          |

**Complication (%)**

| Measure          | Std. Spends ($) Mean (95% CI) | Quality (%) Mean (95% CI) |
|------------------|-------------------------------|--------------------------|
| 90-day ED visit  | 18.6 (23.2 - 4.6)             | 18.3 (23.3 - 5.0)        |
| 90-day mortality | 2.3 (2.1 - 0.3)               | 2.4 (2.2 - 0.2)          |

**Hispanic patients**

| Service                        | Std. Spends ($) Mean (95% CI) | Quality (%) Mean (95% CI) |
|-------------------------------|-------------------------------|--------------------------|
| Index hospitalization         | 13,238 (12,539 - 699)         | 13,153 (12,440 - 713)    |
| Readmission                   | 1,449 (1,305 - 144)           | 1,304 (1,311 - 7)        |
| Institutional post-acute care | 7,423 (5,728 - 1,696)         | 6,402 (5,069 - 1,333)    |
| Long-term care hospital       | 187 (61 - 126)                | 202 (154 - 49)           |
| Inpatient rehabilitation      | 1,583 (1,500 - 83)            | 1,863 (1,317 - 547)      |
| Skilled nursing facility      | 5,580 (4,070 - 1,510)         | 4,217 (3,513 - 704)      |
| Home health                   | 2,286 (2,309 - 22)            | 2,203 (2,107 - 97)       |
| Swing bed                     | 74 (97 - 24)                  | 119 (85 - 34)            |
| Outpatient service            | 450 (621 - 171)               | 537 (668 - 131)          |
| Physician service             | 3,354 (3,222 - 131)           | 3,237 (3,083 - 154)      |

**Health Service Use**

| Measure                             | Std. Spends ($) Mean (95% CI) | Quality (%) Mean (95% CI) |
|-------------------------------------|-------------------------------|--------------------------|
| Discharge to home health (%)        | 36.2 (43.4 - 7.2)             | 37.5 (40.1 - 2.6)        |
| Discharge to home (%)               | 9.6 (15.6 - 6.0)              | 17.0 (23.9 - 6.9)        |
| Days in institutional post-acute care | 14.1 (9.8 - 4.3)             | 10.9 (8.7 - 2.2)         |
| Days in hospital                    | 4.6 (4.0 - 0.5)               | 4.2 (3.8 - 0.5)          |

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| Quality of Care (%) |   |   |   |   |   |   |   |
|---------------------|---|---|---|---|---|---|---|
| Complication        | 3.8| 3.1| -0.6| 3.4| 2.4| -0.9| 0.7|[−0.3, 1.7]| 0.165 |
| 90-day ED visit     | 15.8| 21.0| 5.2| 16.6| 21.4| 4.9| 0.1|[−1.6, 1.9]| 0.890 |
| 90-day mortality    | 2.3| 1.9| -0.4| 2.0| 1.7| -0.3| 0.2|[−0.4, 0.9]| 0.468 |

Notes: a Outcome violates parallel pre-trend assumption and should be interpreted with caution. Column (1)-(6) show unadjusted value and Column (7) adjusted value. All analyses used linear regression models at the episode level, and adjusted for the interaction between a treatment MSA measure (i.e., whether a joint replacement occurred in treatment MSAs) and a post-CJR measure (i.e., whether a joint replacement occurred during the post-CJR period), and three-way interactions between a treatment MSA measure, a post-CJR measure, and race/ethnicity measures (black and Hispanic measures with white as the reference group). Models also included interactions between race/ethnicity and post-CJR measure, interactions between race/ethnicity and treatment MSA measure, race/ethnicity measures, binary measures of each hospital to account for time-invariant hospital characteristics, and binary measures of each year and quarter. Models also adjusted for patient age, gender, and surgery type.
### eTable 4. Changes in racial/ethnic differences for secondary outcomes under CJR (N=747,098)

|                          | White vs. Black | White vs. Hispanic |                      |                      |                      |                      |
|--------------------------|-----------------|--------------------|----------------------|----------------------|----------------------|----------------------|
|                          | Unadjusted      | Adjusted           | 95% CI               | P-value              | Unadjusted           | Adjusted           | 95% CI               | P-value              |
|                          | difference in   | change under CJR   |                      |                      | difference in        | change under CJR   |                      |                      |
|                          | treatment       |                    |                      |                      | treatment MSAs       |                    |                      |                      |
|                          | MSAs pre-CJR    |                    |                      |                      | pre-CJR              |                    |                      |                      |
| Standardized costs ($)   |                 |                    |                      |                      |                      |                    |                      |                      |
| Index hospitalization    | 80              | -36                | [-135, 62]           | 0.468                | -71                  | 83                  | [-55, 221]           | 0.238                |
| Readmission              | 250             | 186                | [-143, 516]          | 0.265                | -183                 | -117                | [-459, 225]          | 0.501                |
| Institutional post-acute care | 2,381       | -713               | [-1,338, -87]        | 0.026                | -1,107               | -237                | [-829, 355]          | 0.430                |
| Long-term care hospital  | 86              | -13                | [-158, 132]          | 0.864                | 11                   | -67                 | [-179, 46]           | 0.244                |
| Inpatient rehabilitation | 705             | -399               | [-943, 145]          | 0.149                | -404                 | -50                 | [-428, 327]          | 0.792                |
| Skilled nursing facility | 1,701           | -236               | [-703, 230]          | 0.318                | -669                 | -194                | [-667, 279]          | 0.420                |
| Home health              | 250             | 86                 | [-64, 236]           | 0.259                | 13                   | 145                 | [-22, 313]           | 0.088                |
| Swing bed               | -112            | -65                | [-322, 192]          | 0.621                | -44                  | 74                  | [-31, 179]           | 0.166                |
| Outpatient service      | 76              | 20                 | [-39, 79]            | 0.507                | -142                 | 24                  | [-53, 100]           | 0.539                |
| Physician service       | 91              | -16                | [-122, 90]           | 0.768                | -72                  | 5                   | [-97, 106]           | 0.930                |
| Health Service Use      |                 |                    |                      |                      |                      |                    |                      |                      |
| Discharge to home health$^a$ (%) | -6.5          | 3.8                | [0.1, 7.5]           | 0.043                | 5.2                  | 3.7                 | [0.4, 6.9]           | 0.027                |
| Discharge to home$^b$ (%) | -6.9           | -0.4               | [-3.2, 2.4]          | 0.786                | 0.1                  | -1.9                | [-5.3, 1.5]          | 0.266                |
| Days in institutional post-acute care | 4.1           | -0.6               | [-1.6, 0.3]          | 0.189                | -1.8                 | -0.7                | [-1.6, 0.1]          | 0.085                |
| Days in hospital        | 0.3             | 0.1                | [0.0, 0.2]           | 0.162                | -0.1                 | 0.0                 | [-0.1, 0.1]          | 0.672                |
| Quality of Care (%)     |                 |                    |                      |                      |                      |                    |                      |                      |
| Complication            | -0.9            | -0.1               | [-0.9, 0.7]          | 0.827                | 0.2                  | 0.6                 | [-0.3, 1.6]          | 0.189                |
| 90-day ED visit         | 3.7             | -0.8               | [-2.8, 1.2]          | 0.422                | -2.8                 | 0.0                 | [-1.8, 1.8]          | 0.962                |
| 90-day mortality        | -0.5            | -0.3               | [-0.9, 0.4]          | 0.436                | -0.1                 | 0.2                 | [-0.4, 0.9]          | 0.476                |

**NOTES:** Changes and differences for discharge to home health, discharge to home, complication, 90-day ED visit, and 90-day mortality are listed as percentage-point estimates. $^a$ Outcome violates parallel pre-trend assumption and should be interpreted with caution.
eTable 5. Sensitivity analysis – applying propensity score weighting (N=725,669)

|                                      | Treatment vs. Control | Difference in changes associated with CJR (REF: White) |
|--------------------------------------|-----------------------|--------------------------------------------------------|
|                                      | Adjusted change       | 95% CI        | P-value | Estimate | 95% CI | P-value |
|                                      | associated with CJR   |              |         |          |        |         |
|                                      |  |                  |        |          |        |         |
| **White patients**                   |  |                  |        |          |        |         |
| **Primary outcomes**                 |  |                  |        |          |        |         |
| Total spending ($)                   | -510                   | [-794, -225] | 0.001  |          |        |         |
| Discharge to institutional post-acute care (%) | -3.1                   | [-5.4, -0.7] | 0.013  |          |        |         |
| 90-day readmission (%)               | -1.8                   | [-3.4, -0.2] | 0.029  |          |        |         |
| **Secondary outcomes**               |  |                  |        |          |        |         |
| Standardized spending ($)            |  |                  |        |          |        |         |
| Index hospitalization                | -27                    | [-69, 15]  | 0.202  |          |        |         |
| Readmission                          | -41                    | [-100, 18] | 0.171  |          |        |         |
| Institutional post-acute care        | -546                   | [-902, -189] | 0.003  |          |        |         |
| Long-term care hospital              | 3                      | [-29, 35]  | 0.840  |          |        |         |
| Inpatient rehabilitation             | -147                   | [-445, 151] | 0.332  |          |        |         |
| Skilled nursing facility             | -379                   | [-624, -135] | 0.003  |          |        |         |
| Home health                          | -3                     | [-165, 158] | 0.967  |          |        |         |
| Swing bed                            | -23                    | [-71, 26]  | 0.361  |          |        |         |
| Outpatient service                   | 3                      | [-22, 28]  | 0.802  |          |        |         |
| Physician service                    | -39                    | [-100, 21] | 0.202  |          |        |         |
| **Health Service Use**               |  |                  |        |          |        |         |
| Discharge to home health (%)         | 2.8                     | [-1.8, 7.3] | 0.227  |          |        |         |
| Discharge to home (%)                | 0.3                     | [-3.3, 3.8] | 0.888  |          |        |         |
| Days in institutional post-acute care | -1.0                   | [-1.6, -0.5] | 0.001  |          |        |         |
| Days in hospital                     | 0.0                     | [-0.1, 0.0] | 0.184  |          |        |         |
| **Quality of Care (%)**              |  |                  |        |          |        |         |
| Complication                         | 0.1                     | [-0.2, 0.3] | 0.609  |          |        |         |
| 90-day ED visit                      | -0.1                    | [-0.6, 0.4] | 0.638  |          |        |         |
| 90-day mortality                     | 0.0                     | [-0.1, 0.2] | 0.923  |          |        |         |
### Black patients

| Primary outcomes                      |  |  |  |  |  |
|---------------------------------------|--------------|-----------------|-----------------|-----------------|-----------------|
| Total spending ($)                    | -451         | [-1,173, 270]   | 0.219           | 59              | [-572, 689]     | 0.855           |
| Discharge to institutional post-acute care (%) | -6.7         | [-10.6, -2.9]   | 0.001           | -3.7            | [-6.5, -0.8]    | 0.013           |
| 90-day readmission (%)                | -3.9         | [-6.8, -0.9]    | 0.010           | -2.1            | [-4.4, 0.2]     | 0.076           |

| Secondary outcomes                   |  |  |  |  |  |
|--------------------------------------|--------------|-----------------|-----------------|-----------------|-----------------|
| Standardized spending ($)            |  |  |  |  |  |
| Index hospitalization                | -32          | [-134, 71]      | 0.544           | -5              | [-99, 90]       | 0.922           |
| Readmission                          | 180          | [-142, 501]     | 0.272           | 221             | [-100, 541]     | 0.176           |
| Institutional post-acute care        | -1,351       | [-2,045, -658]  | 0.000           | -806            | [-1,419, -193]  | 0.010           |
| Long-term care hospital              | -27          | [-178, 124]     | 0.722           | -30             | [-178, 11]      | 0.684           |
| Inpatient rehabilitation             | -668         | [-1,425, 89]    | 0.083           | -521            | [-1,212, 169]   | 0.138           |
| Skilled nursing facility             | -572         | [-1,179, 35]    | 0.065           | -192            | [-681, 296]     | 0.438           |
| Home health                          | 69           | [-192, 331]     | 0.602           | 73              | [-81, 226]      | 0.351           |
| Swing bed                            | -84          | [-320, 152]     | 0.483           | -62             | [-292, 168]     | 0.598           |
| Outpatient service                   | 11           | [-57, 79]       | 0.749           | 8               | [-57, 73]       | 0.812           |
| Physician service                    | -23          | [-139, 93]      | 0.693           | 16              | [-89, 122]      | 0.763           |

### Quality of Care (%)

|  |  |  |  |  |  |
|------------------------------------|--------------|-----------------|-----------------|-----------------|-----------------|
| Complication                       | -0.2         | [-1.0, 0.6]     | 0.635           | -0.3            | [-1.1, 0.5]     | 0.522           |
| 90-day ED visit                    | -0.8         | [-2.9, 1.2]     | 0.428           | -0.7            | [-2.8, 1.4]     | 0.499           |
| 90-day mortality                   | -0.5         | [-1.2, 0.2]     | 0.144           | -0.5            | [-1.2, 0.2]     | 0.141           |

### Hispanic patients

| Primary outcomes                      |  |  |  |  |  |
|---------------------------------------|--------------|-----------------|-----------------|-----------------|-----------------|
| Total spending ($)                    | -517         | [-1,289, 254]   | 0.187           | -8              | [-722, 707]     | 0.983           |
| Discharge to institutional post-acute care (%) | -4.1         | [-7.9, -0.3]    | 0.033           | -1.1            | [-4.3, 2.2]     | 0.529           |
| 90-day readmission (%)                | -1.4         | [-3.6, 0.9]     | 0.230           | 0.4             | [-1.6, 2.4]     | 0.679           |

| Secondary outcomes                   |  |  |  |  |  |
|--------------------------------------|--------------|-----------------|-----------------|-----------------|-----------------|
| Standardized spending ($)            |  |  |  |  |  |

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|                             | Estimate | Lower CI | Upper CI | p-value | Lower CI | Upper CI | p-value |
|-----------------------------|----------|----------|----------|---------|----------|----------|---------|
| **Index hospitalization**   | 44       | [-103, 191] | 0.556    | 71      | [-71, 213] | 0.325    |
| **Readmission**             | -183     | [-489, 123] | 0.241    | -142    | [-447, 164] | 0.362    |
| **Institutional post-acute care** | -680    | [-1,405, 46] | 0.066    | -134    | [-857, 589] | 0.715    |
| **Long-term care hospital** | -32      | [-151, 87] | 0.598    | -35     | [-149, 79] | 0.543    |
| **Inpatient rehabilitation**| -96      | [-610, 419] | 0.714    | 51      | [-486, 588] | 0.851    |
| **Skilled nursing facility**| -579     | [-1,108, -50] | 0.032    | -200    | [-666, 267] | 0.399    |
| **Home health**             | 121      | [-135, 377] | 0.352    | 125     | [-47, 296] | 0.153    |
| **Swing bed**               | 27       | [-67, 121] | 0.574    | 49      | [-57, 156] | 0.360    |
| **Outpatient service**      | 52       | [-28, 132] | 0.204    | 49      | [-33, 130] | 0.240    |
| **Physician service**       | 1        | [-126, 127] | 0.994    | 40      | [-65, 145] | 0.454    |
| **Health Service Use**      |          |          |          |         |          |          |         |
| Discharge to home health* (%) | 5.6     | [0.1, 11.1] | 0.047    | 2.8     | [-0.8, 6.3] | 0.129    |
| Discharge to home* (%)      | -1.5     | [-6.3, 3.4] | 0.552    | -1.7    | [-5.2, 1.8] | 0.337    |
| Days in institutional post-acute care | -1.8  | [-2.8, -0.7] | 0.001    | -0.7    | [-1.6, 0.1] | 0.097    |
| Days in hospital            | 0.0      | [-0.2, 0.1] | 0.718    | 0.0     | [-0.1, 0.1] | 0.765    |
| **Quality of Care (%)**     |          |          |          |         |          |          |         |
| Complication                | 0.4      | [-0.6, 1.4] | 0.385    | 0.4     | [-0.6, 1.4] | 0.445    |
| 90-day ED visit             | 0.0      | [-2.1, 2.1] | 0.988    | 0.1     | [-2.0, 2.3] | 0.900    |
| 90-day mortality            | 0.4      | [-0.4, 1.1] | 0.337    | 0.4     | [-0.4, 1.1] | 0.342    |

Notes: Differences and changes are listed as percentage-point estimates except when specified otherwise.
* Outcome violates parallel pre-trend assumption and should be interpreted with caution
eTable 6. Sensitivity analysis – adjusting for baseline health conditionsa (N=747,098)

| White patients                      | Treatment vs. Control | Difference in changes associated with CJR (REF: White) |
|-------------------------------------|-----------------------|-------------------------------------------------------|
|                                     | Adjusted change       | 95% CI       | P-value | Estimate | 95% CI | P-value |
|                                     | associated with CJR   |             |         |          |       |         |
| **Primary outcomes**                |                       |             |         |          |       |         |
| Total spending ($):                 | -469 [-738, -201]     | 0.001       |          |          |       |         |
| Discharge to institutional post-acute care (%): | -2.6 [-4.7, -0.6] | 0.013       |          |          |       |         |
| 90-day readmission (%):             | -1.5 [-2.9, -0.1]     | 0.041       |          |          |       |         |
| **Secondary outcomes**              |                       |             |         |          |       |         |
| Standardized spending ($)           |                       |             |         |          |       |         |
| Index hospitalization               | -22 [-68, 25]         | 0.354       |          |          |       |         |
| Readmission                         | -38 [-95, 20]         | 0.196       |          |          |       |         |
| Institutional post-acute care       | -466 [-804, -128]     | 0.007       |          |          |       |         |
| Long-term care hospital             | 3 [-31, 37]           | 0.862       |          |          |       |         |
| Inpatient rehabilitation            | -85 [-384, 213]       | 0.573       |          |          |       |         |
| Skilled nursing facility            | -359 [-587, -131]     | 0.002       |          |          |       |         |
| Home health                         | -3 [-149, 142]        | 0.963       |          |          |       |         |
| Swing bed                           | -25 [-71, 21]         | 0.291       |          |          |       |         |
| Outpatient service                  | 8 [-16, 32]           | 0.511       |          |          |       |         |
| Physician service                   | -31 [-83, 22]         | 0.249       |          |          |       |         |
| **Health Service Use**              |                       |             |         |          |       |         |
| Discharge to home health (%)        | 2.4 [-1.8, 6.6]       | 0.257       |          |          |       |         |
| Discharge to home (%)               | 0.2 [-3.3, 3.7]       | 0.898       |          |          |       |         |
| Days in institutional post-acute care | -1.0 [-1.5, -0.5]   | 0.000       |          |          |       |         |
| Days in hospital                    | 0.0 [-0.1, 0.0]       | 0.299       |          |          |       |         |
| **Quality of Care (%)**             |                       |             |         |          |       |         |
| Complication                        | 0.0 [-0.2, 0.2]       | 0.764       |          |          |       |         |
| 90-day ED visit                     | 0.0 [-0.5, 0.5]       | 0.940       |          |          |       |         |
| 90-day mortality                    | 0.0 [-0.2, 0.1]       | 0.894       |          |          |       |         |
### Black patients

| **Primary outcomes** |  |  |  |  |  |  |
|----------------------|--|--|--|--|--|--|
| Total spending ($)   | -456 | [-1,171, 259] | 0.210 | 14 | [-595, 623] | 0.964 |
| Discharge to institutional post-acute care (%) | -5.9 | [-9.6, -2.2] | 0.002 | -3.2 | [-6.1, -0.4] | 0.027 |
| 90-day readmission (%) | -3.0 | [-5.8, -0.3] | 0.030 | -1.6 | [-3.5, 0.4] | 0.120 |

| **Secondary outcomes** |  |  |  |  |  |  |
|------------------------|--|--|--|--|--|--|
| Standardized spending ($) |  |  |  |  |  |  |
| Index hospitalization  | -49 | [-153, 55] | 0.354 | -27 | [-125, 70] | 0.583 |
| Readmission            | 171 | [-159, 501] | 0.308 | 209 | [-119, 536] | 0.210 |
| Institutional post-acute care | -1,143 | [-1,853, -433] | 0.002 | -677 | [-1,301, -53] | 0.034 |
| Long-term care hospital| -7  | [-153, 138] | 0.921 | -10 | [-156, 135] | 0.888 |
| Inpatient rehabilitation| -478 | [-1,117, 160] | 0.141 | -393 | [-939, 153] | 0.157 |
| Skilled nursing facility| -569 | [-1,112, -16] | 0.044 | -210 | [-667, 248] | 0.367 |
| Home health            | 83  | [-149, 314] | 0.483 | 86  | [-64, 236]  | 0.260 |
| Swing bed              | -89 | [-351, 174] | 0.506 | -64 | [-320, 192] | 0.623 |
| Outpatient service     | 32  | [-31, 95]   | 0.313 | 24  | [-35, 83]   | 0.420 |
| Physician service      | -35 | [-148, 79]  | 0.547 | -4  | [-107, 99]  | 0.939 |

| **Health Service Use** |  |  |  |  |  |  |
|------------------------|--|--|--|--|--|--|
| Discharge to home health (%) | 6.1  | [0.8, 11.3] | 0.024 | 3.7 | [0.0, 7.3] | 0.049 |
| Discharge to home (%)     | -0.2 | [-4.5, 4.1] | 0.929 | -0.4 | [-3.2, 2.4] | 0.767 |
| Days in institutional post-acute care | -1.6 | [-2.7, -0.4] | 0.006 | -0.6 | [-1.5, 0.4] | 0.231 |
| Days in hospital         | 0.0  | [-0.1, 0.2] | 0.437 | 0.1 | [0.0, 0.2] | 0.114 |

| **Quality of Care (%)** |  |  |  |  |  |  |
|-------------------------|--|--|--|--|--|--|
| Complication            | 0.0  | [-0.8, 0.8] | 0.990 | 0.0 | [-0.8, 0.7] | 0.945 |
| 90-day ED visit         | -0.6 | [-2.5, 1.2] | 0.503 | -0.7 | [-2.6, 1.3] | 0.499 |
| 90-day mortality        | -0.2 | [-0.9, 0.4] | 0.513 | -0.2 | [-0.9, 0.4] | 0.526 |

### Hispanic patients

| **Primary outcomes** |  |  |  |  |  |  |
|----------------------|--|--|--|--|--|--|
| Total spending ($)   | -435 | [-1,140, 269] | 0.224 | 34 | [-620, 689] | 0.918 |
| Discharge to institutional post-acute care (%) | -4.3 | [-7.6, -1.0] | 0.011 | -1.7 | [-4.5, 1.1] | 0.241 |
| 90-day readmission (%) | -1.6 | [-3.8, 0.5] | 0.142 | -0.1 | [-1.9, 1.6] | 0.889 |

| **Secondary outcomes** |  |  |  |  |  |  |
|------------------------|--|--|--|--|--|--|
| Standardized spending ($) |  |  |  |  |  |  |

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| Health Service Use                        | Differences | Changes       | p-Value  |
|------------------------------------------|-------------|---------------|----------|
| Index hospitalization                    | 62          | [-82, 206]    | 0.396    | 84       | [-52, 220] | 0.225    |
| Readmission                              | -152        | [-503, 199]   | 0.393    | -114     | [-464, 236] | 0.520    |
| Institutional post-acute care            | -694        | [-1,300, -88] | 0.025    | -228     | [-821, 366] | 0.450    |
| Long-term care hospital                  | -63         | [-175, 49]    | 0.265    | -66      | [-179, 46]  | 0.247    |
| Inpatient rehabilitation                 | -134        | [-525, 257]   | 0.500    | -49      | [-427, 330] | 0.801    |
| Skilled nursing facility                 | -546        | [-1,071, -21] | 0.042    | -187     | [-655, 282] | 0.432    |
| Home health                              | 142         | [-85, 370]    | 0.219    | 146      | [-21, 313]  | 0.086    |
| Swing bed                                | 50          | [-44, 143]    | 0.299    | 74       | [-30, 179]  | 0.163    |
| Outpatient service                       | 33          | [-42, 107]    | 0.391    | 25       | [-52, 101]  | 0.525    |
| Physician service                        | -24         | [-140, 92]    | 0.687    | 7        | [-98, 112]  | 0.897    |

Notes: Differences and changes are listed as percentage-point estimates except when specified otherwise.

* We measured base health conditions by calculating each person’s Elixhauser readmission score (using their diagnosis codes during the previous year prior to the index admission) and creating quartiles of the Elixhauser readmission score.
**eTable 7. Sensitivity analysis – Intent-to-treat analysis (N=805,546)**

|                                | Treatment vs. Control | Difference in changes associated with CJR (REF: White) |
|--------------------------------|-----------------------|--------------------------------------------------------|
|                                | Adjusted change       | 95% CI | P-value | Estimate | 95% CI | P-value |
|                                | associated with CJR   |        |         |          |        |         |
| **White patients**             |                       |        |         |          |        |         |
| Primary outcomes               |                       |        |         |          |        |         |
| Total spending ($)             | -357                  | [-622, -92] | 0.008  |          |        |         |
| Discharge to institutional post-acute care (%) | -2.2                  | [-4.2, -0.2] | 0.032  |          |        |         |
| 90-day readmission (%)         | -1.5                  | [-2.9, -0.2] | 0.027  |          |        |         |
| Secondary outcomes            |                       |        |         |          |        |         |
| Standardized spending ($)     |                       |        |         |          |        |         |
| Index hospitalization         | -22                   | [-55, 10] | 0.178  |          |        |         |
| Readmission                   | -28                   | [-83, 28] | 0.326  |          |        |         |
| Institutional post-acute care | -421                  | [-740, -103] | 0.010 |          |        |         |
| Long-term care hospital       | 2                     | [-29,33] | 0.885  |          |        |         |
| Inpatient rehabilitation      | -122                  | [-402, 159] | 0.394 |          |        |         |
| Skilled nursing facility      | -291                  | [-512, -71] | 0.010 |          |        |         |
| Home health                   | 9                     | [-130, 148] | 0.895 |          |        |         |
| Swing bed                     | -11                   | [-59, 38] | 0.663  |          |        |         |
| Outpatient service            | 10                    | [-14, 33] | 0.420  |          |        |         |
| Physician service             | -25                   | [-76, 27] | 0.351  |          |        |         |
| Health Service Use            |                       |        |         |          |        |         |
| Discharge to home health (%)  | 2.5                   | [-1.5, 6.5] | 0.214 |          |        |         |
| Discharge to home (%)         | -0.3                  | [-3.6, 3.0] | 0.848 |          |        |         |
| Days in institutional post-acute care | -0.8                  | [-1.4, -0.3] | 0.001 |          |        |         |
| Days in hospital              | 0.0                   | [-0.1, 0.0] | 0.388 |          |        |         |
| Quality of Care (%)           |                       |        |         |          |        |         |
| Complication                  | 0.0                   | [-0.2, 0.2] | 0.874 |          |        |         |
| 90-day ED visit               | 0.1                   | [-0.4, 0.6] | 0.802 |          |        |         |
| 90-day mortality              | 0.0                   | [-0.2, 0.1] | 0.675 |          |        |         |

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| **Black patients** |  |  |  |  |  |  |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| **Primary outcomes** |  |  |  |  |  |  |
| Total spending ($) | -440 | [-1,129, 250] | 0.210 | -82 | [-686, 522] | 0.789 |
| Discharge to institutional post-acute care (%) | -5.5 | [-9.1, -1.9] | 0.003 | -3.3 | [-6.2, -0.5] | 0.022 |
| 90-day readmission (%) | -2.9 | [-5.5, -0.3] | 0.030 | -1.4 | [-3.2, 0.5] | 0.160 |
| **Secondary outcomes** |  |  |  |  |  |  |
| Standardized spending ($) |  |  |  |  |  |  |
| Index hospitalization | -73 | [-126, -20] | 0.008 | -50 | [-102, 1] | 0.057 |
| Readmission | 146 | [-159, 452] | 0.346 | 174 | [-130, 477] | 0.260 |
| Institutional post-acute care | -1,034 | [-1,710, -359] | 0.003 | -613 | [-1,211, -15] | 0.045 |
| Long-term care hospital | -8 | [-144, 127] | 0.902 | -11 | [-146, 125] | 0.875 |
| Inpatient rehabilitation | -438 | [-1,026, 149] | 0.143 | -317 | [-821, 188] | 0.217 |
| Skilled nursing facility | -504 | [-1,032, 25] | 0.062 | -213 | [-651, 226] | 0.340 |
| Home health | 87 | [-135, 310] | 0.439 | 78 | [-66, 222] | 0.287 |
| Swing bed | -84 | [-334, 167] | 0.511 | -73 | [-319, 173] | 0.559 |
| Outpatient service | 28 | [-29, 86] | 0.332 | 19 | [-35, 73] | 0.494 |
| Physician service | -41 | [-155, 72] | 0.472 | -17 | [-117, 83] | 0.739 |
| **Health Service Use** |  |  |  |  |  |  |
| Discharge to home health (%) | 6.2 | [1.2, 11.1] | 0.015 | 3.6 | [0.2, 7.1] | 0.039 |
| Discharge to home (%) | -0.6 | [-4.6, 3.4] | 0.754 | -0.3 | [-3.0, 2.4] | 0.817 |
| Days in institutional post-acute care | -1.4 | [-2.5, -0.3] | 0.011 | -0.6 | [-1.5, 0.3] | 0.215 |
| Days in hospital | 0.0 | [-0.1, 0.2] | 0.416 | 0.1 | [0.0, 0.2] | 0.140 |
| **Quality of Care (%)** |  |  |  |  |  |  |
| Complication | -0.1 | [-0.9, 0.7] | 0.800 | -0.1 | [-0.9, 0.6] | 0.759 |
| 90-day ED visit | -0.7 | [-2.5, 1.1] | 0.429 | -0.8 | [-2.6, 1.1] | 0.401 |
| 90-day mortality | -0.2 | [-0.9, 0.4] | 0.459 | -0.2 | [-0.9, 0.4] | 0.516 |

| **Hispanic patients** |  |  |  |  |  |  |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| **Primary outcomes** |  |  |  |  |  |  |
| Total spending ($) | -664 | [-1,343, 16] | 0.056 | -306 | [-948, 336] | 0.348 |
| Discharge to institutional post-acute care (%) | -4.4 | [-7.5, -1.3] | 0.006 | -2.2 | [-4.9, 0.4] | 0.100 |
| 90-day readmission (%) | -1.8 | [-3.8, 0.2] | 0.079 | -0.3 | [-1.9, 1.4] | 0.751 |
| **Secondary outcomes** |  |  |  |  |  |  |
| Standardized spending ($) |  |  |  |  |  |  |

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| Index hospitalization | -6 | [-78, 66] | 0.871 | 16 | [-55, 88] | 0.653 |
|-----------------------|----|----------|-------|----|-----------|-------|
| Readmission           | -216 | [-552, 119] | 0.205 | -189 | [-523, 146] | 0.267 |
| Institutional post-acute care | -675 | [-1,249, -100] | 0.022 | -253 | [-814, 307] | 0.374 |
| Long-term care hospital | 12 | [-132, 155] | 0.873 | 9 | [-137, 155] | 0.900 |
| Inpatient rehabilitation | -108 | [-504, 288] | 0.591 | 13 | [-377, 404] | 0.946 |
| Skilled nursing facility | -615 | [-1,137, -93] | 0.021 | -324 | [-796, 148] | 0.178 |
| Home health           | 157 | [-64, 378] | 0.164 | 147 | [-16, 311] | 0.076 |
| Swing bed             | 37 | [-50, 123] | 0.403 | 48 | [-50, 145] | 0.339 |
| Outpatient service    | 26 | [-41, 94] | 0.444 | 17 | [-53, 86] | 0.634 |
| Physician service     | -46 | [-152, 60] | 0.389 | -22 | [-117, 73] | 0.650 |

### Health Service Use

| Discharge to home health (%) | 5.7 | [1.1, 10.3] | 0.015 | 3.2 | [0.2, 6.2] | 0.037 |
| Discharge to home (%)        | -1.3 | [-5.5, 2.9] | 0.543 | -1.0 | [-4.0, 2.1] | 0.538 |
| Days in institutional post-acute care | -1.8 | [-2.8, -0.8] | 0.000 | -1.0 | [-1.8, -0.1] | 0.022 |
| Days in hospital             | -0.1 | [-0.2, 0.1] | 0.319 | 0.0 | [-0.1, 0.1] | 0.497 |

### Quality of Care (%)

| Complication | 0.0 | [-0.8, 0.7] | 0.957 | 0.0 | [-0.8, 0.7] | 0.920 |
| 90-day ED visit | -0.5 | [-2.3, 1.2] | 0.539 | -0.6 | [-2.4, 1.1] | 0.495 |
| 90-day mortality | -0.1 | [-0.7, 0.5] | 0.728 | -0.1 | [-0.7, 0.5] | 0.805 |

Notes: Differences and changes are listed as percentage-point estimates except when specified otherwise. We ran models using 75 treatment and 119 control MSAs, based on the intention-to-treat approach used in prior studies.4,5
eTable 8. Sensitivity analysis – Instrumental variable analysis (N=805,546)

|                                      | Treatment vs. Control | Difference in changes associated with CJR (REF: White) |
|--------------------------------------|-----------------------|--------------------------------------------------------|
|                                      | Adjusted change       | 95% CI        | P-value | Estimate | 95% CI | P-value |
|                                      | associated with CJR   |               |         |          |        |         |
| **White patients**                   |                       |               |         |          |        |         |
| **Primary outcomes**                 |                       |               |         |          |        |         |
| Total spending ($)                   | -406                  | [-694, 118]   | 0.006   |          |        |         |
| Discharge to institutional post-acute care (%) | -2.8                  | [-5.0, -0.6]  | 0.014   |          |        |         |
| 90-day readmission (%)               | -2.1                  | [-3.6, -0.5]  | 0.009   |          |        |         |
| **Secondary outcomes**               |                       |               |         |          |        |         |
| Standardized spending ($)            |                       |               |         |          |        |         |
| Index hospitalization                | -16                   | [-61, 29]     | 0.477   |          |        |         |
| Readmission                          | -38                   | [-98, 22]     | 0.218   |          |        |         |
| Institutional post-acute care        | -565                  | [-915, -216]  | 0.002   |          |        |         |
| Long-term care hospital              | -1                    | [-33, 30]     | 0.929   |          |        |         |
| Inpatient rehabilitation             | -215                  | [-513, 84]    | 0.157   |          |        |         |
| Skilled nursing facility             | -345                  | [-586, -103]  | 0.005   |          |        |         |
| Home health                          | 25                    | [-136, 186]   | 0.761   |          |        |         |
| Swing bed                            | -5                    | [-56, 47]     | 0.864   |          |        |         |
| Outpatient service                   | 10                    | [-15, 35]     | 0.440   |          |        |         |
| Physician service                    | -38                   | [-95, 20]     | 0.197   |          |        |         |
| **Health Service Use**               |                       |               |         |          |        |         |
| Discharge to home health (%)         | 3.7                   | [-0.7, 8.1]   | 0.099   |          |        |         |
| Discharge to home (%)                | -0.9                  | [-4.4, 2.7]   | 0.623   |          |        |         |
| Days in institutional post-acute care | -1.0                  | [-1.6, -0.4]  | 0.001   |          |        |         |
| Days in hospital                     | 0.0                   | [-0.1, 0.0]   | 0.340   |          |        |         |
| **Quality of Care (%)**              |                       |               |         |          |        |         |
| Complication                         | 0.0                   | [-0.2, 0.2]   | 0.817   |          |        |         |
| 90-day ED visit                      | 0.2                   | [-0.3, 0.7]   | 0.524   |          |        |         |
| 90-day mortality                     | 0.0                   | [-0.2, 0.1]   | 0.789   |          |        |         |
## Black patients

### Primary outcomes

| Outcome                                           | Estimate | CI       | p-value | Estimate | CI       |
|---------------------------------------------------|----------|----------|---------|----------|----------|
| Total spending ($)                                | -316     | [-1,060, 427] | 0.403  | 90       | [-551, 730] |
| Discharge to institutional post-acute care (%)    | -6.2     | [-10.0, -2.3] | 0.002  | -3.3     | [-6.3, -0.4] |
| 90-day readmission (%)                            | -3.4     | [-6.3, -0.4] | 0.025  | -1.3     | [-3.4, 0.8] |

### Secondary outcomes

| Outcome                                           | Estimate | CI       | p-value | Estimate | CI       |
|---------------------------------------------------|----------|----------|---------|----------|----------|
| Standardized spending ($)                         |          |          |         |          |          |
| Index hospitalization                             | -28      | [-129, 73] | 0.586  | -12      | [-108, 85] |
| Readmission                                       | 173      | [-148, 495] | 0.288  | 211      | [-107, 529] |
| Institutional post-acute care (%)                 | -1,130   | [-1,862, -398] | 0.003  | -565     | [-1,202, 72] |
| Long-term care hospital                           | -22      | [-169, 126] | 0.775  | -20      | [-168, 128] |
| Inpatient rehabilitation                          | -527     | [-1,204, 150] | 0.126  | -313     | [-894, 269] |
| Skilled nursing facility                          | -514     | [-1,099, 72] | 0.085  | -169     | [-642, 304] |
| Home health                                       | 114      | [-138, 366] | 0.374  | 89       | [-64, 242] |
| Swing bed                                         | -68      | [-306, 171] | 0.576  | -63      | [-299, 173] |
| Outpatient service                                | 41       | [-20, 103] | 0.188  | 32       | [-26, 90] |
| Physician service                                 | -36      | [-155, 84] | 0.559  | 2        | [-104, 108] |

### Health Service Use

| Outcome                                           | Estimate | CI       | p-value | Estimate | CI       |
|---------------------------------------------------|----------|----------|---------|----------|----------|
| Discharge to home health (%)                       | 7.3      | [1.7, 12.8] | 0.011  | 3.6      | [-0.1, 7.3] |
| Discharge to home (%)                              | -1.1     | [-5.5, 3.3] | 0.620  | -0.2     | [-3.1, 2.7] |
| Days in institutional post-acute care              | -1.5     | [-2.7, -0.3] | 0.017  | -0.5     | [-1.4, 0.5] |
| Days in hospital                                   | 0.1      | [-0.1, 0.2] | 0.343  | 0.1      | [0.0, 0.2] |

### Quality of Care (%)

| Outcome                                           | Estimate | CI       | p-value | Estimate | CI       |
|---------------------------------------------------|----------|----------|---------|----------|----------|
| Complication                                      | -0.1     | [-0.9, 0.7] | 0.808  | -0.1     | [-0.9, 0.6] |
| 90-day ED visit                                   | -0.6     | [-2.6, 1.4] | 0.543  | -0.8     | [-2.8, 1.2] |
| 90-day mortality                                  | -0.3     | [-1.0, 0.4] | 0.375  | -0.3     | [-1.0, 0.4] |

## Hispanic patients

### Primary outcomes

| Outcome                                           | Estimate | CI       | p-value | Estimate | CI       |
|---------------------------------------------------|----------|----------|---------|----------|----------|
| Total spending ($)                                | -566     | [-1,355, 222] | 0.158  | -161     | [-896, 575] |
| Discharge to institutional post-acute care (%)    | -4.8     | [-8.2, -1.4] | 0.006  | -2.0     | [-4.8, 0.8] |
| 90-day readmission (%)                            | -2.3     | [-4.4, -0.1] | 0.040  | -0.2     | [-1.9, 1.5] |

### Secondary outcomes

| Outcome                                           | Estimate | CI       | p-value | Estimate | CI       |
|---------------------------------------------------|----------|----------|---------|----------|----------|
| Standardized spending ($)                         |          |          |         |          |          |
| Index hospitalization | 89 | [-47, 224] | 0.199 | 105 | [-24, 234] | 0.111 |
|-----------------------|----|------------|-------|-----|-----------|-------|
| Readmission           | -241 | [-606, 125] | 0.196 | -203 | [-567, 161] | 0.273 |
| Institutional post-acute care | -734 | [-1,383, -85] | 0.027 | -169 | [-773, 435] | 0.582 |
| Long-term care hospital | 20 | [-145, 184] | 0.811 | 21 | [-144, 187] | 0.799 |
| Inpatient rehabilitation | -164 | [-617, 290] | 0.478 | 51 | [-379, 481] | 0.815 |
| Skilled nursing facility | -635 | [-1,238, -31] | 0.040 | -290 | [-828, 249] | 0.290 |
| Home health           | 179 | [-85, 443] | 0.184 | 154 | [-38, 346] | 0.116 |
| Swing bed             | 44 | [-51, 139] | 0.365 | 48 | [-61, 157] | 0.382 |
| Outpatient service    | 41 | [-30, 112] | 0.259 | 31 | [-42, 105] | 0.403 |
| Physician service     | -44 | [-158, 71] | 0.454 | -6 | [-104, 93] | 0.906 |
| Health Service Use    |     |            |       |     |            |       |
| Discharge to home health (\%) | 6.5 | [1.3, 11.7] | 0.015 | 2.8 | [-0.6, 6.1] | 0.104 |
| Discharge to home (\%) | -1.7 | [-6.1, 2.7] | 0.450 | -0.8 | [-4.1, 2.5] | 0.630 |
| Days in institutional post-acute care | -2.0 | [-3.0, -0.9] | 0.000 | -0.9 | [-1.8, -0.1] | 0.033 |
| Days in hospital      | 0.0 | [-0.2, 0.1] | 0.500 | 0.0 | [-0.1, 0.1] | 0.802 |
| Quality of Care (\%)  |     |            |       |     |            |       |
| Complication          | 0.3 | [-0.7, 1.4] | 0.513 | 0.3 | [-0.7, 1.3] | 0.538 |
| 90-day ED visit       | -0.5 | [-2.4, 1.3] | 0.571 | -0.7 | [-2.6, 1.2] | 0.462 |
| 90-day mortality      | 0.0 | [-0.7, 0.7] | 0.982 | 0.0 | [-0.7, 0.7] | 0.968 |

Notes: Differences and changes are listed as percentage-point estimates except when specified otherwise.
This study included all MSAs that CMS identified as eligible for CJR participation. CMS first excluded 192 of the 388 total MSAs due to high participation rates in the Bundled Payments for Care Improvement (BPCI) Initiative or insufficient volume of joint replacements. The remaining 196 MSAs were then grouped into eight strata based on population size and historical episode spending. CMS randomly selected MSAs for CJR participation within each stratum, oversampling MSAs in strata with higher historical spending. CMS defined the initial sample of 75 treatment (i.e., CJR participation) MSAs and 121 control MSAs in July 2015. However, based on more recent BPCI participation rates during July through September 2015, CMS excluded 8 treatment and 17 control MSAs, leading to 67 treatment MSAs and 104 control MSAs. The final list of treatment and control MSAs is available on the CMS website. We excluded the San Juan MSA from our control group because it was affected by Hurricane Maria in 2017. Our sample contained 67 treatment and 103 control MSAs.

Notes: MSA is metropolitan statistical area, BPCI is Bundled Payment for Care Improvement Initiative, and CJR is Comprehensive Care for Joint Replacement model.
eMethods 2. Main regression model specification

The triple-difference approach measures the difference between three estimates derived through the difference-in-differences (DD) approach. In our case, we considered the DD estimate for white, black, and Hispanic patients. The DD estimate for white patients is the average difference (occurring with the CJR implementation) in their outcomes in treatment MSAs subtracted by the average differences in the control MSAs. Likewise, the DD estimates for black and Hispanic patients measure change in outcomes under CJR model among black and Hispanic patients, respectively. The difference between the DD estimates of white, black, and Hispanic patients measures the differential changes across patients with different race/ethnicity under CJR.

More specifically, we estimated the following care-episode-level regression:

\[ Y_{ihmt} = \beta_0 + \beta_1 \text{Treatment}_m \times \text{Post}_t \times \text{Black}_i + \beta_2 \text{Treatment}_m \times \text{Post}_t \times \text{Hispanic}_i + \beta_3 \text{Treatment}_m \times \text{Post}_t \]

\[ + \beta_4 \text{Treatment}_m \times \text{Black}_i \times \text{Post}_t \times \text{Hispanic}_i + \beta_5 \text{Post}_t \times \text{Black}_i + \beta_6 \text{Post}_t \times \text{Hispanic}_i \]

\[ + \beta_8 \text{Black}_i + \beta_9 \text{Hispanic}_i + X + \sum_{h} \phi_{h} \text{Hospital}_h + \sum_{t} \gamma_{t} \text{Year}_t + \sum_{t} \theta_{t} \text{Quarter}_t + \epsilon_{ihmt} \]

where \( Y_{ihmt} \) is an outcome variable for joint replacement \( i \) that occurred in hospital \( h \) located in MSA \( m \) in year \( t \). \( \text{Treatment}_m \) takes a value of 1 if a joint replacement occurred in the treatment MSAs and 0 otherwise. \( \text{Post}_t \) takes a value of 1 if a joint replacement occurred after April 2016 and 0 otherwise. \( \text{Black}_i \) takes a value of 1 for black patients and \( \text{Hispanic}_i \) takes a value of 1 for Hispanic patients. \( X \) includes patient age groups, gender, and surgery type (elective knee, elective hip, and hip fracture surgery). \( \phi_{h} \text{Hospital}_h, \gamma_{t} \text{Year}_t, \) and \( \theta_{t} \text{Quarter}_t \) represent binary measures of each hospital, year, and quarter.

\( \beta_1 \) and \( \beta_2 \) measures changes in black-white and Hispanic-white differences under CJR while \( \beta_3 \) measured the changes associated with CJR for white patients.

We obtained changes associated with CJR for black patients by adding \( \beta_1 \) and \( \beta_3 \) (using a post-estimation command that computes linear combinations of coefficient estimates) and changes associated with CJR for Hispanic patients by adding \( \beta_2 \) and \( \beta_3 \). We clustered standard errors on MSAs to account for correlation in error terms within MSAs. Our analysis also included sample weights in regressions to correct for any bias caused by stratified sampling.
eMethods 3. Propensity score calculation and weight application

As a sensitivity analysis, we used propensity score weighting in an attempt to account for differences in hospital and patient composition between treatment and control MSAs. Propensity score weighting, also known as inverse probability of treatment weighting, is a method designed to make observations in the treatment and control groups more comparable by weighing observations based on their probability of being in the treatment group.\(^8\)

Rather than running this method on the entire population, we stratified our study population based on year of joint replacement and race/ethnicity (e.g. white patients with a surgery in 2013, black patients with a surgery in 2017, etc.). We chose to run this process separately for each racial/ethnic group to avoid adjusting out meaningful differences between the racial/ethnic groups. The stratified process instead attempts to make observations in treatment and control MSAs comparable within each racial/ethnic group. We chose to additionally stratify the process by year, as the differences between treatment and control populations may change over time, especially if the CJR program lead to changes in patient composition.

Within each strata, we used patient demographics, hospital characteristics and patient baseline health status to predict whether the surgery occurred within a treatment or control MSA. More specifically, our models contained the following covariates: CMS MSA sampling cluster, hospital volume of joint replacements, hospital bed count, hospital ownership type (public, non-profit, or for-profit), hospital major teaching status, hospital disproportionate patient percentage (DPP), patient gender, patient age, patient Medicaid eligibility, type of joint replacements (elective hip, elective knee, and hip fracture surgery), and Elixhauser mortality and readmission risk scores.

We then used the resulting predictive probability of each surgery occurring in a treatment MSA to calculate Average Treatment Effect (ATE) weights (equation 1).

\[
\begin{align*}
    w_i &= \begin{cases} 
    \frac{1}{P(Treat_i = 1|X_i)} & \text{where Treat} = 1 \\
    \frac{1}{1 - P(Treat_i = 1|X_i)} & \text{where Treat} = 0 
    \end{cases} 
\end{align*}
\]

where \(P(Treat_i = 1|X_i)\) is the predicted probability that surgery \(i\) occurred in a treatment MSA, conditional on covariates \(X_i\). Resulting propensity score weights were multiplied by the CJR sampling weights to create final weights that were applied to all models. We used kernel density plots to confirm that treatment and control groups met the sufficient overlap or common support required for propensity score weighting.

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**eMethods 4. Instrumental variable approach**

As a sensitivity analysis, we used an instrumental variable approach based on previous studies including Finkelstein et al. (2018), Haas et al. (2019), and Barnett et al. (2019).

Our sample for the instrumental variable analysis included 75 treatment and 121 control MSAs that CMS initially defined for CJR participation in July 2015. We used the initial assignment to CJR (whether an observation was from 75 treatment MSAs versus 121 control MSAs) as an instrumental variable for the final assignment to CJR (whether an observation was from 67 treatment MSAs where CJR was implemented versus other 129 MSAs).

The first stage equation was

\[
\text{Treat}_m = \alpha_0 + \alpha_1 \text{InitialTreat}_m + \sum_k \gamma_k \text{MSA\_Group}_m + \epsilon_{ihmt}
\]

where \(\text{Treat}_m\) takes a value of 1 if a joint replacement occurred in the 67 treatment MSAs and 0 otherwise. \(\text{InitialTreat}_m\) takes a value of 1 if a joint replacement occurred in the 75 treatment MSAs initially defined by CMS and 0 otherwise. \(\text{MSA\_Group}_m\) is eight strata that CMS determined based on population size and historical joint replacement episode spending. CMS randomly selected MSAs for CJR participation within each stratum, oversampling MSAs in strata with higher historical spending.

The second stage equation was

\[
Y_{ihmt} = \beta_0 + \beta_1 \text{Treat}_m \times \text{Post}_t \times \text{Black}_i + \beta_2 \text{Treat}_m \times \text{Post}_t \times \text{Hispanic}_i + \beta_3 \text{Treat}_m \times \text{Post}_t \\
+ \beta_4 \text{Treat}_m \times \text{Black}_i + \beta_5 \text{Treat}_m \times \text{Hispanic}_i + \beta_6 \text{Post}_t \times \text{Black}_i + \beta_7 \text{Post}_t \times \text{Hispanic}_i \\
+ \beta_8 \text{Black}_i + \beta_9 \text{Hispanic}_i + X_{B} + \sum_h \phi_h \text{Hospital}_h + \sum_t \gamma_t \text{Year}_t + \sum_t \delta_t \text{Quarter}_t + \epsilon_{ihmt}
\]
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