

## Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.

**eTable 1. Baseline Characteristics of Treatment and Control Groups Before Propensity Score Match**

	<b>Treatment Group (CJR)</b>	<b>Control Group (non-CJR)</b>	<b>Standardized Mean Difference</b>
<b>Area Characteristics</b>			
Metropolitan Statistical Areas (MSAs)	75	121	N/A
Average MSA Population	1,345,687	952,203	N/A
<b>Hospital Characteristics</b>			
Number of Hospitals	815	955	N/A
Teaching Hospital (%)	54.4	51.7	0.045
Average Hospital Beds	347	322	0.094
<b>Episode Characteristics</b>			
Number of Total CJR Episodes	168,028	217,074	N/A
Hip Fracture Episodes (%)	13.4	12.2	0.036
Age (yrs)	72.8	72.6	0.025
Female (%)	64.5	63.9	0.013
CMS-HCC Risk Score <sup>‡</sup>	1.10	1.07	0.022
Length of Stay (days)	4.24	4.08	0.085
Medicare Part A Spending (\$)†	23,639	22,664	0.068
Index Admission Spending	12,815	12,776	0.024
90-Day Post-Acute Care Spending	10,824	9,888	0.068
Skilled Nursing Facility	5,613	5,076	0.054
Inpatient Rehabilitation Facility	1,454	1,200	0.052
Home Health Agency	1,860	1,767	0.052
Readmission Payments	1,185	1,070	0.024
Long Term Care Payments	111	143	0.012
Psychiatric Unit Payments	22	22	0.001
Outpatient Payments	581	609	0.028
Medicare Part B Spending (\$)⁂	3,032	2,876	0.111
Total 90-Day Episode Spending (\$)⁂	26,727	25,435	0.087

**Notes:** This table compares baseline characteristics at the area, hospital, and episode level between the 75 MSAs randomly assigned into treatment and 121 control MSAs (intention-to-treat). All MS-DRG 470 and 469 episodes were included, which denoted Major Joint Replacement or Reattachment of Lower Extremity without and with major complication conditions, respectively. Characteristics were calculated from the pre-intervention period January 2014 through July 2015 (prior to initial CJR announcement).

<sup>‡</sup> Beneficiary risk scores were calculated using the CMS-HCC model, 2017 model year program.

<sup>†</sup> All Medicare Part A spending outcomes were derived using the 100% Medicare Part A claims data.

<sup>&</sup> Medicare Part B and total 90-day episode spending were derived using the 5% Medicare Part B claims data. Thus, these results are not directly comparable to the Part A spending results, as they were derived from a subsample of Medicare beneficiaries.

**eTable 2. Changes in Spending and Quality of Care Associated with Random Assignment into the CJR Without and Among Episodes with Primary Hip Fracture Diagnoses**

*A. Changes in Spending and Quality of Care Excluding Episodes with Primary Hip Fracture*

	<b>Change in Outcome Associated with the CJR</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
<b>Spending Outcomes (\$)</b>			
Medicare Part A Spending <sup>†</sup>	-575	(-857, -292)	<0.001
Index Admission Spending	4	(-21, 29)	0.77
90-Day Post-Acute Care Spending	-578	(-857, -300)	<0.001
Skilled Nursing Facility	-345	(-555, -135)	<0.001
Inpatient Rehabilitation Facility	-258	(-406, -110)	<0.001
Home Health Agency	35	(-57, 126)	0.46
Readmission Spending	-42	(-136, 52)	0.38
Long Term Care Hospital	15	(-15, 45)	0.33
Psychiatric Units	-8	(-17, 2)	0.11
Outpatient Payments	24	(3, 45)	0.02
Medicare Part B Spending <sup>&amp;</sup>	-78	(-215, 59)	0.27
Total 90-Day Episode Spending <sup>&amp;</sup>	-591	(-1564, 382)	0.23
<b>Quality Outcomes</b>			
Hospitalization LOS (days)	-0.02	(-0.07, 0.03)	0.48
90-Day Readmission Rate (%)	-0.02	(-0.08, 0.04)	0.50
90-Day Complication Rate (%) <sup>‡</sup>	0.26	(-0.04, 0.56)	0.09
30-Day Mortality Rate (%)	0.06	(-0.12, 0.23)	0.52
90-Day Mortality Rate (%)	0.02	(-0.14, 0.19)	0.80

**Notes:** This table reports estimates of changes in outcomes at the episode level associated with random assignment of the index hospital into the CJR model, excluding cases with primary diagnoses of hip fracture. The model was adjusted for age, sex, CMS Hierarchical Condition Category (CMS-HCC) risk score, indicator for hip fracture status, hospital fixed effect, a vector of quarter indicators, and interactions

between each quarter and CJR status. Pre-intervention spanned January 2014 to July 2015; post-intervention April 2016 to March 2018. Both MS-DRG 470 and 469 episodes were included.

† All Medicare Part A spending outcomes were derived using the 100% Medicare Part A claims data.

& Medicare Part B and total 90-day episode spending were derived using the 5% Medicare Part B claims data. Thus, these results are not directly comparable to the Part A spending results, as they were derived from a subsample of Medicare beneficiaries.

‡ Primary Elective THA/TKA 90-day complication rate

*B. Changes in Spending and Quality of Care of Episodes Among Primary Hip Fracture Episodes*

	<b>Change in Outcome Associated with the CJR</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
<b>Spending Outcomes (\$)</b>			
Medicare Part A Spending <sup>†</sup>	-688	(-1628, 252)	0.15
Index Admission Spending	-47	(-194, 100)	0.53
90-Day Post-Acute Care Spending	-641	(-1562, 281)	0.17
Skilled Nursing Facility	332	(-443, 1107)	0.40
Inpatient Rehabilitation Facility	-730	(-1255, -205)	0.01
Home Health Agency	33	(-73, 140)	0.54
Readmission Spending	-145	(-479, 190)	0.40
Long Term Care Hospital	-120	(-368, 129)	0.35
Psychiatric Units	-7	(-71, 58)	0.84
Outpatient Payments	-5	(-69, 59)	0.88
Medicare Part B Spending <sup>&amp;</sup>	52	(-283, 387)	0.76
Total 90-Day Episode Spending <sup>&amp;</sup>	-4009	(-8255, 238)	0.06
<b>Quality Outcomes</b>			
Hospitalization LOS (days)	-0.07	(-0.21, 0.07)	0.30
90-Day Readmission Rate (%)	0.05	(-0.31, 0.41)	0.78
90-Day Complication Rate (%) <sup>‡</sup>	N/A	N/A	N/A
30-Day Mortality Rate (%)	-0.56	(-2.26, 1.14)	0.52
90-Day Mortality Rate (%)	-0.53	(-2.15, 1.09)	0.52

**Notes:** This table reports estimates of changes in outcomes at the episode level associated with random assignment of the index hospital into the CJR model, including only cases with primary diagnoses of hip fracture. The model was adjusted for age, sex, CMS Hierarchical Condition Category (CMS-HCC) risk score, indicator for hip fracture status, hospital fixed effect, a vector of quarter indicators, and interactions between each quarter and CJR status. Pre-intervention spanned January 2014 to July 2015; post-intervention April 2016 to March 2018. Both MS-DRG 470 and 469 episodes were included.

<sup>†</sup> All Medicare Part A spending outcomes were derived using the 100% Medicare Part A claims data.

<sup>&</sup> Medicare Part B and total 90-day episode spending were derived using the 5% Medicare Part B claims data. Thus, these results are not directly comparable to the Part A spending results, as they were derived from a subsample of Medicare beneficiaries.

<sup>‡</sup> Primary Elective THA/TKA 90-day complication rate; insufficient data for analysis in this subgroup.

**eTable 3. Tests of Pre-intervention Trends Between Treatment and Control**

	<b>Differential Change Pre-Intervention (\$)</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
Medicare Part A Spending	61	(-183, 305)	0.62
Index Admission Spending	1	(-25, 28)	0.92
90-Day Post-Acute Care Spending	60	(-182, 301)	0.63
Skilled Nursing Facility	143	(-22, 308)	0.09
Inpatient Rehabilitation Facility	-13	(-133, 106)	0.83
Home Health Agency	-19	(-86, 47)	0.57
Readmission Payments	-9	(-86, 69)	0.83
Long Term Care Hospital	-34	(-85, 16)	0.18
Psychiatric Units	-10	(-21, 1)	0.09
Outpatient Payments	3	(-14, 20)	0.77
Medicare Part B Spending	-42	(-130, 47)	0.36
Total 90-Day Episode Spending	-279	(-1110, 551)	0.51

**Notes:** This table reports model estimates of differential changes in pre-intervention spending at the episode level associated with random assignment of the index hospital into the CJR model. The model was adjusted for age, sex, CMS Hierarchical Condition Category (CMS-HCC) risk score, indicator for hip fracture status, hospital fixed effect, a vector of quarter indicators, and interactions between each quarter and CJR status. Pre-intervention spanned January 2014 to July 2015. Both MS-DRG 470 and 469 episodes were included.



**eTable 4. Changes in Spending Associated with the CJR Among 67 Fully-Treated Metropolitan Statistical Areas**

	<b>Change in Outcome Associated with the CJR</b>	<b>Baseline Pre-CJR Average in CJR Group</b>	<b>Percent Change Relative to Baseline (%)</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
<b>Spending Outcomes (\$)</b>					
Medicare Part A Spending <sup>†</sup>	-522	23,608	-2.2	(-820, -225)	<0.001
Index Admission Spending	-1	12,816	0.0	(-30, 29)	0.963
90-Day Post-Acute Care Spending	-522	10,792	-4.8	(-816, -227)	<0.001
Skilled Nursing Facility	-198	5,520	-3.6	(-418, 23)	0.08
Inpatient Rehabilitation Facility	-323	1,497	-21.6	(-489, -157)	<0.001
Home Health Agency	50	1,870	2.7	(-35, 134)	0.25
Readmission Spending	-41	1,185	-3.4	(-138, 56)	0.411
Long Term Care Hospital	-15	115	-13.0	(-57, 27)	0.49
Psychiatric Units	-10	22	-44.4	(-21, 2)	0.10
Outpatient Payments	15	584	2.6	(-5, 35)	0.14

Medicare Part B Spending <sup>&amp;</sup>	-10	3,040	-0.3	(-21, 2)	0.10
Total 90-Day Episode Spending <sup>&amp;</sup>	-58	26,736	-0.2	(-195, 78)	0.40

\* This table reports sensitivity analyses of changes in spending outcomes at the episode level using the 67 metropolitan statistical areas that were fully treated in the CJR program. Using a two-staged least squares instrumental variables approach, this analysis instrumented for full treatment in the CJR using the initial random assignment into the CJR. Pre-intervention spanned January 2014 to July 2015; post-intervention April 2016 to March 2018. Both MS-DRG 470 and 469 episodes were included.

† All Medicare Part A spending outcomes were derived using the 100% Medicare Part A claims data.

<sup>&</sup> Medicare Part B and total 90-day episode spending were derived using the 5% Medicare Part B claims data. Thus, these results are not directly comparable to the Part A spending results, as they were derived from a subsample of Medicare beneficiaries.

**eTable 5. Changes in Utilization and Patient Characteristics Associated with Random Assignment into the CJR Without and Among Episodes with Primary Hip Fracture Diagnoses**

*A. Changes in Utilization and Patient Characteristics Excluding Episodes with Primary Hip Fracture Diagnoses*

	<b>Change in Outcome Associated with the CJR</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
<b>Utilization Outcomes<sup>†</sup></b>			
DRG 470 Episodes per 1000 Beneficiaries	0.26	(-0.09, 0.61)	0.15
DRG 469 Episodes per 1000 Beneficiaries	0.01	(-0.01, 0.02)	0.32
<b>Patient Characteristics</b>			
Age (years)	-0.09	(-0.33, 0.16)	0.50
Female (%)	0.48	(-0.28, 1.24)	0.22
Hip Fracture Episodes (%)	N/A	N/A	N/A
CMS-HCC Risk Score	-0.01	(-0.03, 0.02)	0.68

*B. Changes in Utilization and Patient Characteristics among Primary Hip Fracture Diagnoses*

	<b>Change in Outcome Associated with the CJR</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
<b>Utilization Outcomes<sup>†</sup></b>			
DRG 470 Episodes per 1000 Beneficiaries	0.03	(-0.01, 0.07)	0.12
DRG 469 Episodes per 1000 Beneficiaries	0.01	(-0.04, 0.02)	0.06
<b>Patient Characteristics</b>			
Age (years)	0.03	(-0.34, 0.40)	0.87
Female (%)	-1.84	(-3.00, -0.67)	0.002
Hip Fracture Episodes (%)	N/A	N/A	N/A
CMS-HCC Risk Score	0.05	(-0.01, 0.11)	0.10

**Notes:** These tables report estimates of changes in utilization outcomes and patient characteristics at the metropolitan statistical area (MSA) level associated with random assignment of the MSA into the CJR model. Dependent variables included a vector of quarter indicators, interactions between each quarter and CJR status, and MSA fixed effect. The CMS Hierarchical Condition Category (CMS-HCC) risk score was calculated using age, sex, and diagnoses. Both MS-DRG 470 and 469 episodes were included.

† Volume of episodes was measured on a quarterly basis at the MSA level. DRG 470 and DRG 469 episodes denote Major Joint Replacement or Reattachment of Lower Extremity without and with major complication conditions, respectively.

**eTable 6. Average Post-Acute Care Usage Rates Among Treatment and Control Groups Before and After the CJR**

		All Episodes		Excluding Hip Fracture Episodes		Hip Fracture Episodes Only	
		Pre-CJR	Post-CJR	Pre-CJR	Post-CJR	Pre-CJR	Post-CJR
Institutional Post-Acute Care Usage Rate <sup>†</sup>	CJR	45.7%	32.3%	38.9%	25.1%	90.6%	87.2%
	non-CJR	44.2%	33.1%	37.6%	26.4%	90.0%	86.7%
Skilled Nursing Facility Usage Rate	CJR	38.3%	28.6%	33.1%	22.6%	73.2%	74.4%
	non-CJR	38.0%	28.6%	32.8%	23.2%	74.4%	71.8%
Inpatient Rehabilitation Facility Usage Rate	CJR	8.8%	4.6%	6.5%	2.9%	23.7%	18.0%
	non-CJR	7.4%	5.5%	5.4%	3.6%	21.4%	19.9%

**Notes:** This table shows unadjusted usage rates of post-acute care among episodes of lower extremity joint replacements (MS-DRG 469 and 470). Any usage of post-acute care following discharge from index hospitalization was counted in these rates.

<sup>†</sup> Institutional post-acute care is defined as skilled nursing facilities and inpatient rehabilitation facilities.

**eTable 7. Changes in Institutional Post-Acute Spending and Length of Stay Associated with Random Assignment into the CJR Among Episodes with Institutional Post-Acute Care, Without and Among Primary Hip Fracture Diagnoses**

*A. Changes in Institutional Post-Acute Spending and Length of Stay Among Episodes with Institutional Post-Acute Care, Excluding Primary Hip Fracture Diagnoses*

	<b>Change in Outcome Associated with the CJR</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
<b>Skilled Nursing Facilities</b>			
SNF Payments (\$)	-1132	(-1551, -713)	<0.001
LOS per Visit (days)	-1.8	(-2.4, -1.2)	<0.001
Payment per Day (\$)	7	(-4, 19)	0.20
<b>Inpatient Rehab Facilities</b>			
IRF Payments (\$)	528	(-514, 1570)	0.32
LOS per Visit (days)	0.1	(-0.3, 0.5)	0.65
Payment per Day (\$)	66	(-25, 157)	0.15

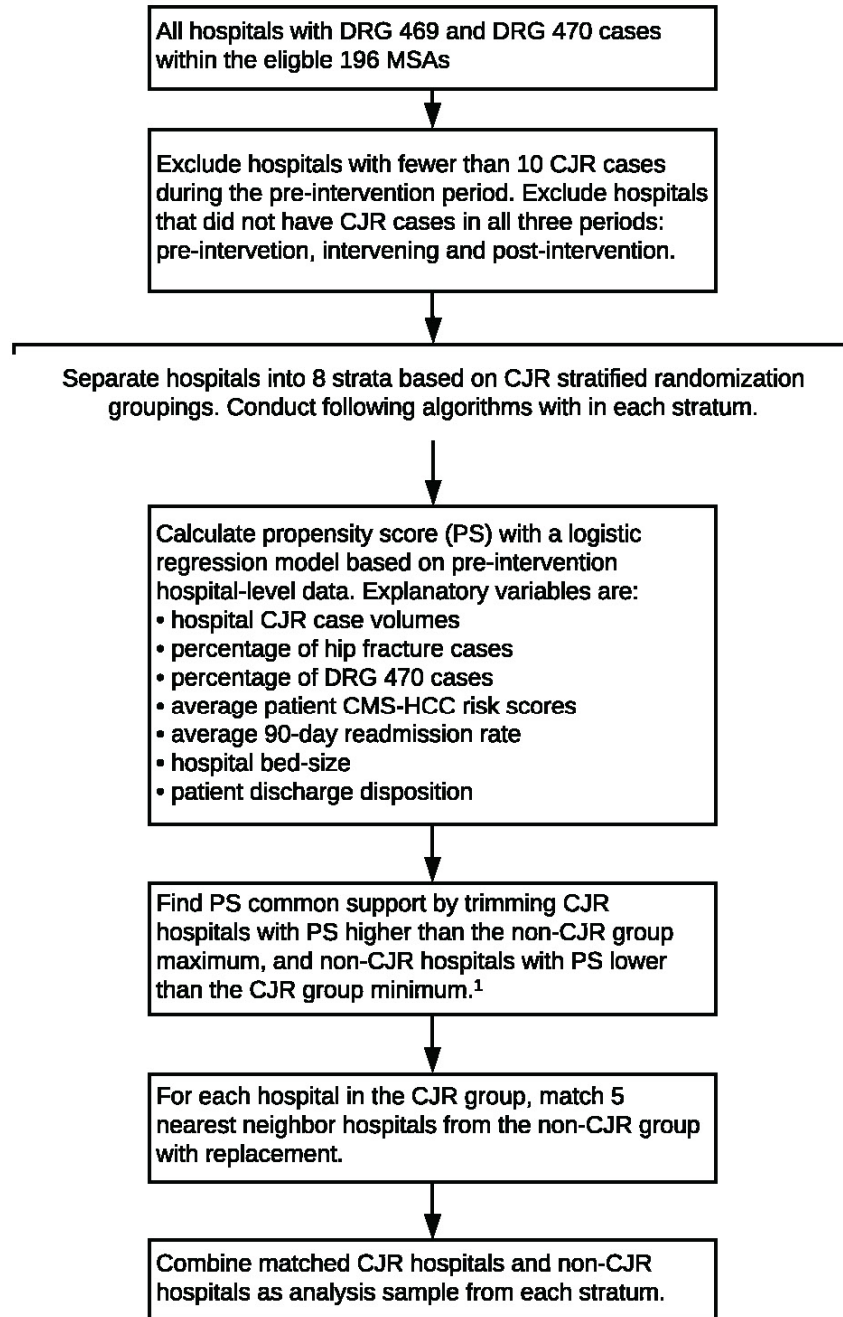
*B. Changes in Institutional Post-Acute Spending and Length of Stay Among Episodes with Institutional Post-Acute Care, With Only Primary Hip Fracture Diagnoses*

	<b>Change in Outcome Associated with the CJR</b>	<b>95% Confidence Interval</b>	<b>P Value</b>
<b>Skilled Nursing Facilities</b>			
SNF Payments (\$)	-152	(-966, 661)	0.71

LOS per Visit (days)	-0.8	(-2.1, 0.5)	0.24
Payment per Day (\$)	13	(-1, 27)	0.08
<b>Inpatient Rehab Facilities</b>			
IRF Payments (\$)	63	(-771, 896)	0.88
LOS per Visit (days)	-0.5	(-1.1, 0.04)	0.07
Payment per Day (\$)	164	(49, 278)	0.01

**Notes:** These tables report episode-level changes in spending, length of stay, and average Medicare payments per day at Skilled Nursing Facilities (SNF) and Inpatient Rehabilitation Facilities (IRF) associated with the CJR for episodes in which the beneficiary was admitted to a SNF or IRF. Percent change was defined as a share of the baseline level of the outcome among this subset of episodes. Both MS-DRG 470 and 469 episodes were included.

**eFigure 1. Description of Propensity Score Matching**



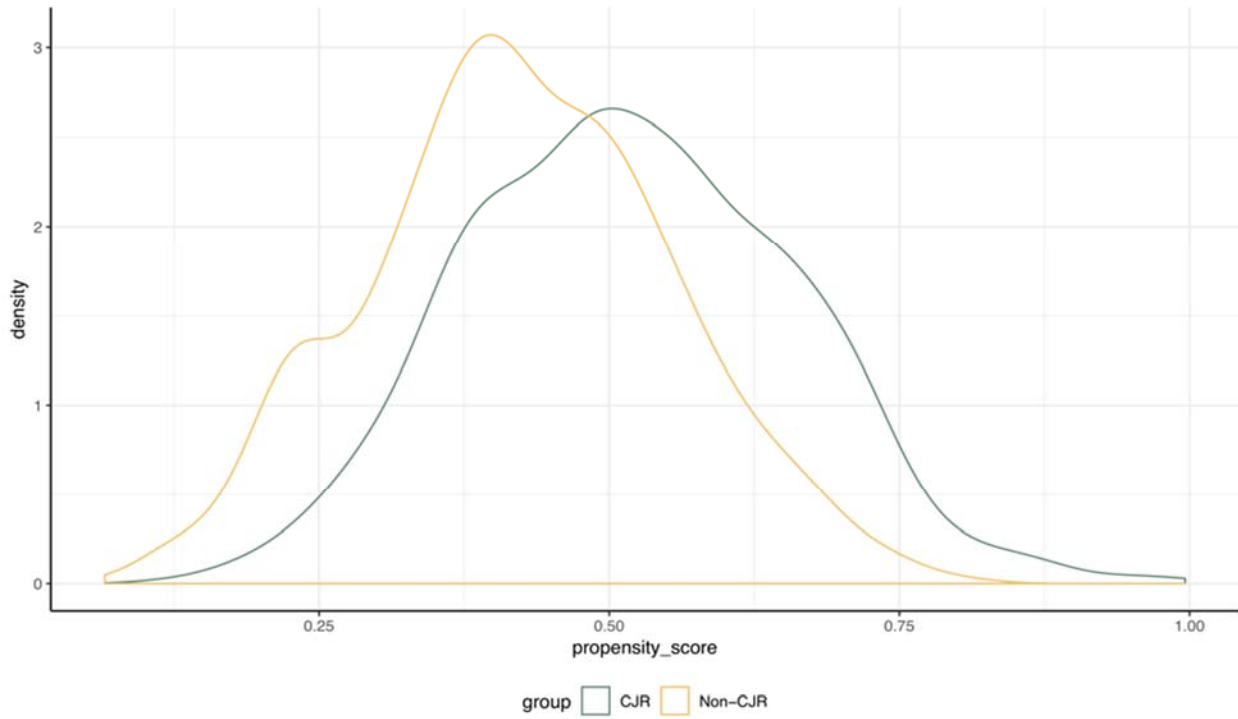
1. Imbens, G., & Rubin, D. (2015). *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge: Cambridge University Press.

**Notes:** This diagram describes the propensity score algorithm. Random assignment into the CJR occurred within 8 strata of metropolitan statistical areas (MSAs), which were determined by the Centers for Medicare and Medicaid Services based on historical spending and population size. The list of strata and MSAs are available at <https://innovation.cms.gov/Files/worksheets/ccjr-populationpayment.xlsx>.



## eFigure 2. Propensity Score Distributions of CJR and Non-CJR Hospitals

### A. Propensity Score Distributions Among All Hospitals



### B. Propensity Score Distributions After Weighting

