

Supplemental Online Content

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

eFigure 1: Schematic of pre- and post-intervention period definition for main analysis, 2013 baseline

		Calendar Quarter															
		1/1/13	4/1/13	7/1/13	10/1/13	1/1/14	4/1/14	7/1/14	10/1/14	1/1/15	4/1/15	7/1/15	10/1/15	1/1/16	4/1/16	7/1/16	10/1/16
BPCI Start Date	1/1/14	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention		Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	4/1/14	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention			Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	7/1/14	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention				Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	10/1/14	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention					Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	1/1/15	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention						Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	4/1/15	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention								Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	7/1/15	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention									Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	10/1/15	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention										Post-BPCI Washout	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	1/1/16	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention											Post-BPCI Washout	Post-Intervention	Not Included - less than 90-days follow-up
	4/1/16	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention												Post-BPCI Washout	Post-Intervention

Abbreviations: Bundled Payment for Care Improvement (BPCI)

This is a schematic representation of the time periods used in the *main analysis* for pre-BPCI intervention and post-BPCI periods across the cohorts of SNF BPCI entrants from 2014 through 2016. Each row represents a different start date when SNFs could enter the BPCI program, starting on 1/1/2014. For each of these periods, the corresponding time period definitions is shown schematically – the fixed baseline matching and pre-intervention period (yellow), the post-intervention period (green) and dropped periods (light green).

Data to perform matching and the pre-intervention period both overlap in the first 3 quarters of 2013.

eFigure 2: Schematic of pre- and post-intervention study periods, sensitivity analysis

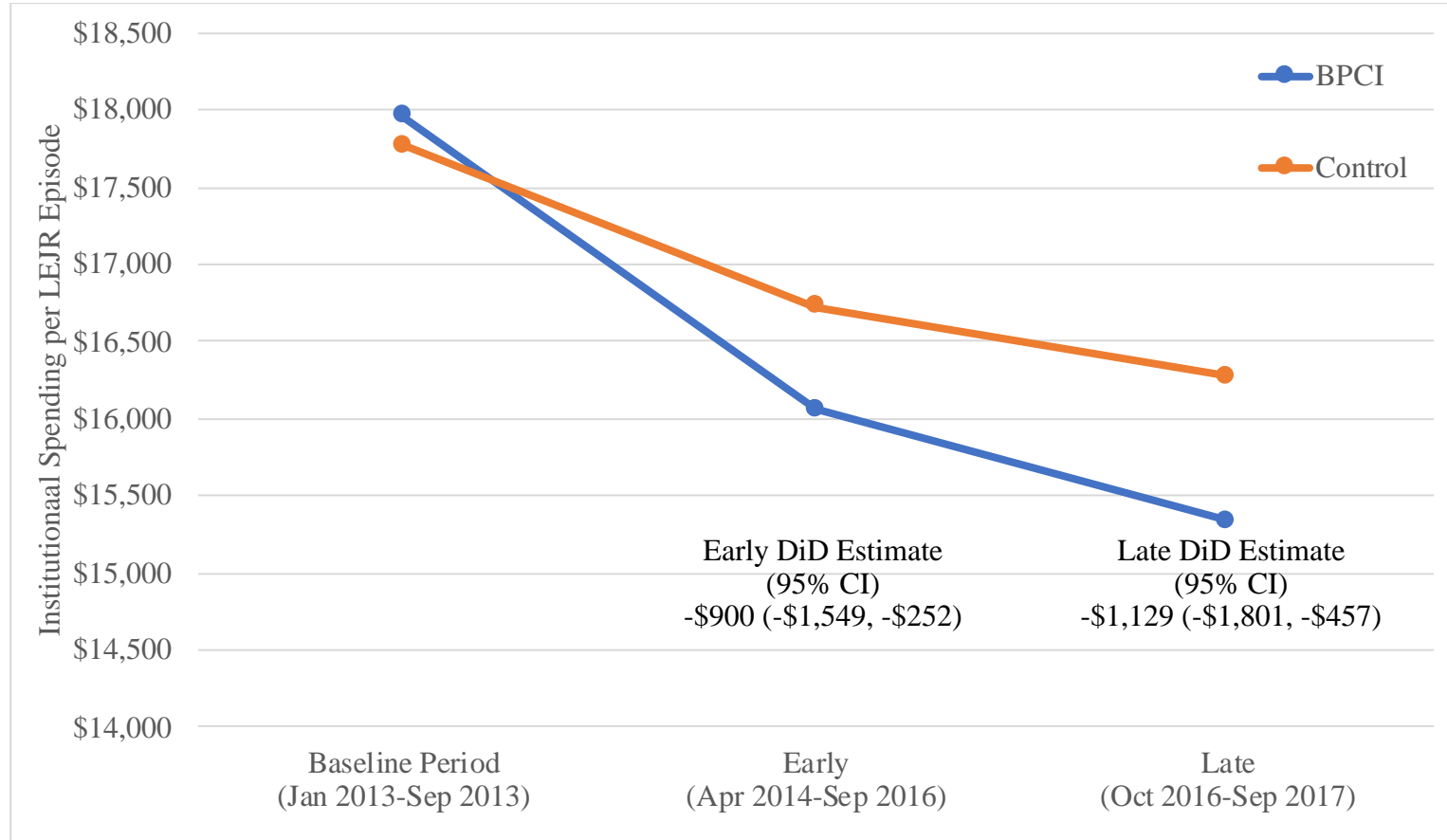
		Calendar Quarter															
		1/1/13	4/1/13	7/1/13	10/1/13	1/1/14	4/1/14	7/1/14	10/1/14	1/1/15	4/1/15	7/1/15	10/1/15	1/1/16	4/1/16	7/1/16	10/1/16
BPCI Start Date	1/1/14	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	4/1/14	Baseline for Matching	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	7/1/14	Baseline for Matching	Baseline for Matching	Baseline Matching and Pre-Intervention	Baseline Matching and Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	10/1/14	Baseline for Matching	Baseline for Matching	Baseline for Matching	Baseline Matching and Pre-Intervention	Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	1/1/15	Baseline for Matching	Baseline for Matching	Baseline for Matching	Baseline for Matching	Pre-Intervention	Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	4/1/15	Baseline for Matching	Baseline for Matching	Baseline for Matching	Baseline for Matching		Pre-Intervention	Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	7/1/15	Baseline for Matching	Baseline for Matching	Baseline for Matching	Baseline for Matching			Pre-Intervention	Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	10/1/15	Baseline for Matching	Baseline for Matching	Baseline for Matching	Baseline for Matching				Pre-Intervention	Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	1/1/16	Baseline for Matching	Baseline for Matching	Baseline for Matching	Baseline for Matching					Pre-Intervention	Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Post-Intervention	Not Included - less than 90-days follow-up
	4/1/16	Baseline for Matching	Baseline for Matching	Baseline for Matching	Baseline for Matching						Pre-Intervention	Pre-Intervention	Pre-Intervention	Pre-BPCI Washout	Post-BPCI Washout	Post-Intervention	Not Included - less than 90-days follow-up

Abbreviations: Bundled Payment for Care Improvement (BPCI)

This is a schematic representation of the time periods used in the *sensitivity analysis* in eTable 2 for pre-BPCI intervention and post-BPCI periods across the cohorts of SNF BPCI entrants from 2014 through 2016.

Each row represents a different start date when SNFs could enter the BPCI program, starting on 1/1/2014. For each of these periods, the corresponding time period definitions is shown schematically – the variable baseline matching period (red) and pre-interventions periods (dark yellow), the post-intervention period (green) and dropped periods (light yellow and light green).

eFigure 3: Trends in Institutional Payment and Difference-in-Differences Estimates in BPCI Model 3 during the Study Period



Abbreviations: Bundled Payment for Care Improvement (BPCI), 95% confidence interval (95% CI), emergency department (ED), skilled nursing facility (SNF)

This shows average institutional spending per LEJR episode for SNFs in BPCI and matched controls in three time periods during the study period: baseline (January 1, 2013 – September 30, 2013), “early” BPCI (April 1, 2014 – September 30, 2016) and “late” BPCI (October 1, 2016 – September 30, 2017). The early and late periods have similar numbers of episodes (early: 7,211 BPCI and 26,562 control; late: 6,103 BPCI and 22,881 control). Post-hoc difference-in-difference estimates for the early and late periods using the same model as the primary outcome analysis are shown in the Figure.

eTable 1: Pre-period outcome trends, intervention and matched control BPCI SNFs

	BPCI		Matched Controls		Difference			
	Monthly Trend	P-value	Monthly Trend	P-value	Difference in Trends	Lower 95% CI	Upper 95% CI	P value
Primary Outcome								
Total institutional spending over 90-d episode	-\$11	0.875	-\$23	0.537	-\$3	-\$180	\$173	0.970
Secondary Payment Outcomes								
Initial SNF stay	\$52	0.276	\$30	0.244	\$2	-\$115	\$119	0.979
Subsequent SNF stays	-\$13	0.717	-\$20	0.184	\$16	-\$64	\$96	0.689
Overall SNF spending (initial + subsequent)	\$39	0.479	\$10	0.747	\$18	-\$122	\$158	0.802
Readmission	\$6	0.799	-\$4	0.544	\$4	-\$36	\$44	0.840
Inpatient rehabilitation facility	\$12	0.088	-\$2	0.728	\$16	\$0	\$33	0.053
Long term acute care hospital	-\$4	0.688	\$2	0.676	-\$4	-\$25	\$17	0.697
Home health agency	-\$63	0.020	-\$28	0.077	-\$38	-\$103	\$27	0.257
Durable medical equipment	-\$1.05	0.003	-\$0.82	0.000	-\$0.12	-\$0.90	\$0.66	0.758
Utilization and Discharge Outcomes								
Average Length of Stay, Initial SNF Admission (Days)	0.016	0.867	0.059	0.236	-0.026	-0.257	0.206	0.828
Average Number of SNF Days, Full Bundle Period (Days)	0.017	0.864	0.017	0.748	-0.015	-0.266	0.236	0.905
Average Days at Home during Bundle Period (Days)	0.039	0.915	0.302	0.123	-0.475	-1.400	0.451	0.315
Discharged Home after Initial SNF Stay (%)	-0.2%	0.342	0.1%	0.498	-0.2%	-0.9%	0.5%	0.551

Use of Home Health Agency after SNF Discharge (%)	-0.3%	0.282	-0.1%	0.436	-0.1%	-0.7%	0.5%	0.777
	BPCI		Matched Controls		Difference			
	Monthly Trend	P-value	Monthly Trend	P-value	Difference in Trends	Lower 95% CI	Upper 95% CI	P value
Patient Outcomes								
ED Use without Admission								
30 Day	0.45%	0.258	0.00%	0.993	0.44%	-0.43%	1.31%	0.321
90 Day	0.21%	0.391	0.01%	0.939	0.19%	-0.38%	0.76%	0.507
Inpatient Readmission								
30 Day	-0.33%	0.074	-0.20%	0.060	-0.15%	-0.59%	0.30%	0.520
90 Day	-0.09%	0.503	-0.14%	0.075	0.02%	-0.30%	0.34%	0.885
Mortality								
30 Day	0.00%	0.967	-0.03%	0.436	0.03%	-0.14%	0.19%	0.766
90 Day	-0.16%	0.158	-0.06%	0.256	-0.14%	-0.40%	0.13%	0.320

eTable 2: Treatment-on-treated sensitivity analyses

	BPCI			Matched Controls			Adjusted Differential Change		
	Baseline Period	Intervention Period	Unadjusted Difference	Baseline Period	Intervention Period	Unadjusted Difference	Difference-in-Differences	Lower 95% CI	Upper 95% CI
Primary Outcome									
Total institutional spending over 90-d episode	\$17,636	\$15,406	-\$2,230	\$17,593	\$16,450	-\$1,143	-\$1,088	-\$1,742	-\$433
Secondary Payment Outcomes									
Overall SNF spending (initial + subsequent)	\$11,915	\$9,915	-\$2,000	\$11,920	\$10,780	-\$1,140	-\$860	-\$1,319	-\$400
Initial SNF stay	\$1,798	\$1,629	-\$169	\$1,847	\$1,889	\$42	-\$210	-\$487	\$66
Subsequent SNF stays	\$13,713	\$11,544	-\$2,168	\$13,766	\$12,668	-\$1,098	-\$1,070	-\$1,590	-\$550
Readmission	\$1,896	\$1,897	\$1	\$1,938	\$2,038	\$100	-\$99	-\$326	\$128
Inpatient rehabilitation facility	\$208	\$146	-\$62	\$123	\$134	\$11	-\$73	-\$266	\$120
Long term acute care hospital	\$136	\$206	\$69	\$152	\$194	\$42	\$27	-\$56	\$110
Home health agency	\$1,635	\$1,586	-\$49	\$1,567	\$1,390	-\$177	\$128	\$42	\$213
Durable medical equipment	\$47	\$27	-\$20	\$47	\$26	-\$21	\$0	-\$3	\$3
Utilization and Discharge Outcomes									
Average Length of Stay, Initial SNF Admission (Days)	21.5	16.9	-4.6	21.9	19.0	-2.90	-1.7	-2.7	-0.7
Average Number of SNF Days, Full Bundle Period (Days)	25.7	20.7	-5.0	26.0	23.2	-2.80	-2.2	-3.2	-1.2
Average Days at Home during Bundle Period (Days)	60.4	65.9	5.4	60.1	63.0	2.95	2.5	1.30	3.65
Discharged Home after Initial SNF Stay (%)	69.7%	61.4%	-8.2%	68.1%	65.3%	-2.8%	-5.4%	-9.2%	-1.6%
Use of Home Health Agency after SNF Discharge (%)	52.0%	60.3%	8.3%	49.9%	53.8%	3.8%	4.4%	2.0%	6.9%

	BPCI			Matched Controls			Adjusted Differential Change		
	Baseline Period	Intervention Period	Unadjusted Difference	Baseline Period	Intervention Period	Unadjusted Difference	Difference-in-Differences	Lower 95% CI	Upper 95% CI
Patient Outcomes									
ED Use without Admission									
30 Day	2.5%	3.4%	0.8%	2.5%	2.9%	0.4%	0.42%	-0.19%	1.03%
90 Day	0.9%	1.1%	0.1%	1.1%	1.2%	0.1%	0.07%	-0.31%	0.46%
Inpatient Readmission									
30 Day	15.9%	16.1%	0.2%	16.3%	17.1%	0.8%	-0.6%	-2.1%	0.9%
90 Day	7.8%	6.8%	-1.0%	8.7%	8.2%	-0.5%	-0.5%	-1.7%	0.6%
Mortality									
30 Day	2.0%	1.5%	-0.5%	1.9%	1.7%	-0.2%	-0.3%	-0.9%	0.2%
90 Day	4.5%	3.6%	-0.9%	4.6%	4.1%	-0.5%	-0.4%	-1.2%	0.4%

Abbreviations: Bundled Payment for Care Improvement (BPCI), 95% confidence interval (95% CI), emergency department (ED), skilled nursing facility (SNF)

Adjusted estimates show the differential change in spending outcomes during the 90-day post-admission bundle period between treatment and control groups after vs. before BPCI implementation. In contrast to the main analysis, these estimates exclude any SNF-quarters where SNFs were not enrolled in BPCI, including post-BPCI dropout quarters. All estimates use standard errors clustered at the SNF level. The differential change estimates can be interpreted as the average within-SNF change attributable to BPCI implementation. For outcome definitions, see Tables 3-5 in the main manuscript.

eTable 3: Other sensitivity analyses

	Main Analysis in Manuscript	Alternate Time Definition (eFigure 2)	Excluding all Admissions from BPCI Model 2 Hospitals	Excluding all Admissions from CJR Hospitals	Only Including SNFs in a Chain	Only Including SNFs NOT in a Chain	Main Analysis without Winsorizing Costs
BPCI Intervention Period Episodes (n)	13314	13314	10156	9751	10139	3175	13314
Primary Outcome							
Total institutional spending over 90-d episode	-1008 (-1603, -414)	-1086 (-1665, -507)	-894 (-1585, -203)	-761 (-1420, -101)	-981 (-1667, -294)	-925 (-2116, 265)	-1244 (-1895, -594)
Secondary Payment Outcomes							
Overall SNF spending	-981 (-1446, -516)	-312 (-576, -48)	-883 (-1402, -365)	-860 (-1348, -373)	-826 (-1353, -300)	-1431 (-2404, -458)	-1199 (-1714, -684)
Initial SNF stay	-847 (-1253, -440)	-953 (-1407, -498)	-814 (-1241, -387)	-814 (-1224, -404)	-632 (-1074, -189)	-1524 (-2463, -585)	-1056 (-1518, -594)
Subsequent SNF stays	-134 (-381, 113)	-180 (-414, 54)	-69 (-361, 222)	-46 (-324, 232)	-194 (-487, 98)	93 (-343, 528)	-143 (-399, 113)
Readmission	-106 (-315, 103)	-95 (-226, 36)	-56 (-304, 193)	-15 (-253, 224)	-158 (-402, 87)	122 (-279, 523)	-132 (-374, 110)
Inpatient rehabilitation facility	-87 (-257, 84)	59 (-18, 137)	-150 (-361, 60)	-52 (-238, 134)	-149 (-358, 61)	147 (-51, 346)	-87 (-257, 84)
Long term acute care hospital	48 (-28, 125)	-348 (-666, -29)	57 (-30, 143)	44 (-51, 140)	24 (-68, 116)	137 (16, 257)	48 (-28, 125)
Home health agency	117 (38, 196)	80 (2, 157)	138 (52, 225)	123 (30, 216)	127 (41, 213)	102 (-87, 292)	126 (44, 208)
Durable medical equipment	0 (-3, 3)	2 (0, 4)	1 (-2, 4)	-1 (-4, 2)	0 (-3, 3)	-2 (-8, 3)	-1 (-5, 3)
Utilization and Discharge Outcomes							
Average Length of Stay, Initial SNF Admission (Days)	-1.5 (-2.4, -0.7)	2.5 (1.5, 3.5)	-1.4 (-2.4, -0.5)	-1.6 (-2.5, -0.7)	-1.2 (-2.1, -0.2)	-2.9 (-4.9, -0.9)	-
Average Number of SNF Days, Full Bundle Period (Days)	-2 (-2.9, -1.1)	0 (-0.1, 0)	-2 (-3, -1)	-1.7 (-2.7, -0.8)	-1.8 (-2.8, -0.7)	-2.7 (-4.6, -0.8)	-
Average Days at Home during Bundle Period (Days)	2.3 (1.2, 3.3)	-1.5 (-2.3, -0.7)	2.3 (1.1, 3.4)	2 (0.9, 3.1)	2.4 (1.2, 3.5)	1.9 (-0.4, 4.2)	-
Discharged Home after Initial SNF Stay (%)	-2.2 (-6.1, 1.8)	-184.6 (-271.2, -98.1)	-3 (-7.5, 1.4)	-2.3 (-6.4, 1.8)	-2.8 (-7.5, 1.9)	0.9 (-5.3, 7)	-

Use of Home Health Agency after SNF Discharge (%)	3.6 (1.4, 5.8)	2.6 (0.4, 4.8)	4.2 (1.8, 6.6)	3.6 (1, 6.3)	3.5 (1.1, 5.9)	4.2 (-0.8, 9.2)	-
	Main Analysis in Manuscript	Alternate Time Definition (eFigure 2)	Excluding all Admissions from BPCI Model 2 Hospitals	Excluding all Admissions from CJR Hospitals	Only Including SNFs in a Chain	Only Including SNFs NOT in a Chain	Main Analysis without Winsorizing Costs
Patient Outcomes							
ED Use without Admission							
30 Day	0.7 (-0.9, 2.2)	-0.2 (-0.6, 0.2)	0.5 (-1.2, 2.3)	1 (-0.9, 2.9)	2.2 (-0.7, 5.1)	0.3 (-4.1, 4.7)	-
90 Day	1.8 (-0.7, 4.3)	0.3 (-0.3, 0.9)	0.1 (-2.8, 3.1)	1.7 (-1.3, 4.7)	-0.7 (-2.9, 1.5)	1.5 (-1.3, 4.2)	-
Inpatient Readmission							
30 Day	-0.4 (-1.4, 0.6)	-1.6 (-2.7, -0.5)	0 (-1.2, 1.2)	-0.1 (-1.3, 1)	-0.6 (-1.8, 0.6)	0.4 (-1.7, 2.4)	-
90 Day	-0.5 (-1.9, 0.8)	-1.6 (-3, -0.2)	0.2 (-1.3, 1.7)	-0.1 (-1.6, 1.5)	-0.5 (-2.1, 1.1)	-0.4 (-3.1, 2.2)	-
Mortality							
30 Day	-0.2 (-0.7, 0.3)	-0.4 (-0.9, 0.1)	-0.2 (-0.7, 0.4)	-0.1 (-0.7, 0.5)	-0.4 (-1, 0.2)	0.3 (-0.6, 1.1)	-

Abbreviations: Bundled Payment for Care Improvement (BPCI), 95% confidence interval (95% CI), emergency department (ED), skilled nursing facility (SNF)

Adjusted estimates show the differential change in spending outcomes during the 90-day post-admission bundle period between treatment and control groups after vs. before BPCI implementation. In contrast to the main analysis, these estimates use varying approaches to the sample or analysis as described in the column headings. All estimates use standard errors clustered at the SNF level. The differential change estimates can be interpreted as the average within-SNF change attributable to BPCI implementation. For outcome definitions, see Tables 3-5 in the main manuscript.