

# Bundled Payment Impacts Uptake of Prescribed Home Health Care

Jun Li, PhD; and Lacey Loomer, PhD

**N**onadherence to medical regimens leads to poor health outcomes, preventable progression of disease, and billions in avoidable health care expenses.<sup>1-5</sup> Home health care (HHC), which helps patients rehabilitate following injury or illness,<sup>6</sup> is increasingly prescribed to help older adults safely recover in the community.<sup>7</sup> However, 1 in 5 older adults in the US who are referred to HHC for postacute recovery after joint replacement surgery do not receive it.<sup>8</sup> Uptake rates are even worse in the general Medicare population, with nearly half not receiving prescribed HHC.<sup>9</sup> Moreover, rates of HHC uptake (ie, HHC use among patients referred to HHC) vary by race and ethnicity, with 15% to 20% lower rates among Black and Hispanic individuals compared with White individuals.<sup>9</sup> Reasons for low HHC uptake rates are poorly understood but may include patient factors, such as concerns about privacy and trust, and provider factors, such as a lack of coordination with postdischarge providers to ensure that all necessary postdischarge treatments are received.<sup>5,10,11</sup>

To improve care coordination and decrease total spending, CMS implemented the Comprehensive Care for Joint Replacement (CJR) Model in April 2016. Hospitals that achieved low Medicare spending while maintaining quality from admission through 90 days after discharge received financial rewards, which incentivized hospitals to more holistically consider the needs of patients receiving major joint replacement surgery.<sup>12</sup> Studies to date have shown that CJR increased HHC utilization in lieu of institutional postacute care, particularly among Black and Hispanic patients.<sup>13-16</sup> Utilization rates, however, do not inform uptake rates because postdischarge referral patterns may have changed under CJR. Thus, it is unclear whether postacute HHC uptake rates improved under CJR.

HHC uptake might improve if CJR led to care improvement, such as more patient engagement and better care coordination.<sup>10</sup> For instance, some CJR hospitals focused on improving patient understanding of postdischarge services and set up monitoring to maintain communication with patients after discharge.<sup>17</sup> In another example, some providers developed narrow HHC networks,<sup>18</sup> which may increase the likelihood of patients receiving HHC as ordered. On the other hand, if CJR hospitals solely focused on

## ABSTRACT

**OBJECTIVE:** To determine whether the CMS Comprehensive Care for Joint Replacement (CJR) Model, which incentivizes coordinated and efficient care, increased home health care (HHC) uptake among patients referred to HHC after major joint replacement surgery.

**STUDY DESIGN:** Cohort study using a difference-in-differences design comparing hospitals in 75 metropolitan statistical areas randomized into CJR by CMS with non-CJR hospitals in 119 areas as controls.

**METHODS:** The primary outcome was the case mix-adjusted, hospital-level HHC uptake rate, which is the rate of patients referred to HHC at hospital discharge receiving an HHC visit within 14 days. Secondary outcomes included HHC uptake rate by race/ethnicity and the quality of HHC agencies used among referrals, which was measured by agency-level improvement in ambulation, unplanned hospitalizations, emergency department visits, time to the first home health visit, and distinct number of agencies.

**RESULTS:** After the launch of CJR, HHC uptake decreased nationally but there was a 3.73–percentage point (4.5%) lower decrease in CJR hospitals; this was driven by White patients (3.54–percentage point differential;  $P = .026$ ). A marginally statistically significant ( $P = .054$ ) 5.05–percentage point differential increase for Black patients was observed due to a slight increase in the treatment group and a large decrease in the control group. There was no statistically significant change for Hispanic or Asian American/Pacific Islander populations. No statistically significant increases were observed in the quality of HHC used.

**CONCLUSIONS:** CJR mitigated a trend of decreased HHC uptake, but more work is needed to improve uptake for larger portions of the patient population. Our results suggest that addressing care coordination incentives via CJR may mitigate some racial disparities.

*Am J Manag Care.* 2025;31(2):66-73. doi:10.37765/ajmc.2025.89677

cutting institutional postacute care without improving postdischarge care quality, then there might be little effect on HHC uptake rates. If true, this could be particularly detrimental to racial/ethnic minority populations for whom uptake of HHC is especially low.<sup>8,9</sup>

Our objective was therefore to determine whether CJR increased HHC uptake after major joint replacement surgery. To account for possible changes in the HHC referral composition, our primary outcome measure was hospital-level, case mix–adjusted uptake rates. We used national data from 2014 to 2018 and a difference-in-differences design to compare uptake rates among patients referred to HHC before and after the adoption of CJR. Second, we assessed whether uptake varied by whether CJR patients were White, Black, Hispanic, or Asian American/Pacific Islander (AAPI). Third, we assessed whether CJR led to the use of higher-quality HHC. Given the continued difficulty in improving patient adherence to recommended medical care and the large shares of patients who do not receive HHC despite referral, our findings provide timely information on the role of bundled payment incentives in addressing patient needs.

## METHODS

### Experimental Design

CMS used a stratified design to randomly select 75 treatment metropolitan statistical areas (MSAs) and 121 control MSAs from a total of 196 MSAs. All eligible hospitals within MSAs selected for CJR were mandated to participate in the program's first 2 years, which lasted from April 2016 through December 2017. Involvement in CJR became voluntary after 2018 ([eAppendix 1](#) [eAppendices available at [ajmc.com](#)]).

### Study Data and Population

Our population included hip or knee joint replacement discharges (diagnosis related group [DRG] 469 or DRG 470) with referrals to HHC from hospitals within 1 of 196 MSAs eligible for the CJR program. From this population, we constructed a sample of 194 MSAs (75 treatment and 119 control MSAs), 1366 hospitals, and 354,861 episodes. To arrive at this sample, we excluded hospitals in the Bundled Payments for Care Improvement initiative because they were exempt from CJR. We included patients with both Medicare Parts A and B coverage in the month of hospitalization through 90 days after discharge who were 65 years or older and qualified for Medicare for reasons besides end-stage renal disease. We included discharges prior to CJR (July 2014 to June 2015) and following CJR (April 2016 to December 2018).

We used several data sources. We used 100% Medicare Provider Analysis and Review data to capture each patient's primary diagnosis and discharge disposition. We used the Outcome and Assessment Information Set (OASIS) to identify HHC use. We identified beneficiary

## TAKEAWAY POINTS

Only 79.17% of patients referred to home health care after joint replacement use it. During the Comprehensive Care for Joint Replacement (CJR) Model, uptake of home health care decreased compared with prior years, but for patients at CJR hospitals, the decrease was mitigated, resulting in a differential increase of 3.73 percentage points (4.5%) in home health care uptake.

- ▶ The difference in uptake was driven by White and Black patients (differentials of 3.54 and 5.05 percentage points, respectively).
- ▶ There is room for improvement to increase uptake of prescribed care, particularly for Hispanic and Asian American/Pacific Islander patients.
- ▶ Regional variation in home health care may explain differences in uptake.

demographic and insurance enrollment information from the Master Beneficiary Summary File Base Segment. We obtained hospital characteristics from the Provider of Services files, bundled payment operational files, American Hospital Association 2014 file, and HHC agency quality information from CareCompare.com. Finally, we obtained zip code poverty rates from the American Community Survey.

### Primary Outcome: HHC Uptake

We sought to determine whether CJR affected HHC uptake rates among referrals to HHC at hospital discharge. Following prior literature,<sup>8,9,19</sup> we defined *HHC uptake* as receipt of a home health visit (as recorded in OASIS data) in the 14 days after referral, and we identified referrals using the discharge destination code in the hospital discharge record. However, because CJR may have changed the composition of referrals, such as increasing referrals to HHC (and home without HHC) and decreasing referrals to institutional postacute care ([eAppendix Table 1](#)), examining unadjusted uptake rates would not allow us to disentangle changes in composition from changes in hospital care that may have affected uptake rates. Thus, we used hospital-level, case mix–adjusted uptake rates as our main outcome measure.

Our case mix–adjusted uptake rate is the ratio of observed to expected uptake counts, scaled by the mean uptake rate in the control group following methods employed by the CMS<sup>20</sup> and Agency for Healthcare Research and Quality.<sup>21</sup> Observed uptake counts were the sum of the total number of discharges that received HHC within 14 days of discharge from each hospital. Expected uptake counts were the sum of expected probabilities of receipt of HHC for each hospital ([eAppendix 2](#)). The overall C statistic of the prediction model was 0.67, comparable to published and widely used models predicting hospital readmission risk.<sup>22</sup>

### Secondary Outcomes

We used 5 hospital-level measures to characterize the average quality of HHC used by those who received care as prescribed. The first 3 were agency-level variables obtained from CareCompare.com that were then aggregated to the hospital level: percentages of patients with (1) improved ambulation between the end and start of HHC, (2) unplanned hospitalizations within 60 days of the start

**TABLE 1.** Overview of Study Sample\*

Characteristics	Treatment		Control	
	Pre-CJR	Post CJR	Pre-CJR	Post CJR
Hospital characteristics				
Teaching, %	42.4	42.4	39.6	39.6
Safety net, %	23.8	23.8	20.4	20.4
For profit, %	20.5	20.5	20.6	20.6
Beds, n (mean)	269.2	269.2	251.0	251.0
Physician integration, %	59.9	59.9	57.7	57.7
Home health integration, %	40.0	40.0	36.1	36.1
SNF integration, %	69.2	69.2	65.9	65.9
MJR characteristics				
MJRs per hospital per month, n (mean)	13.6	14.5	15.3	16.1
Home health referrals per hospital, %	31.6	38.2	31.9	35.6
Home health uptake per hospital, %	83.9	83.1	85.5	80.9
Patient demographics				
Age in years (mean)	73.1	73.6	72.9	73.4
Female, %	60.5	63.4	59.5	62.5
White, %	83.0	82.7	84.4	85.2
Black, %	5.7	5.9	6.1	6.1
Hispanic, %	6.7	6.6	6.1	4.9
AAPI, %	2.2	2.2	1.4	1.4
Elixhauser Comorbidity Index, n (mean)	2.1	2.2	2.1	2.2
Hospitalized 180 days prior, %	9.6	8.0	9.1	8.0
Home health use 180 days prior, %	8.2	7.2	7.9	7.1
Institutional PAC use 180 days prior, %	1.3	1.1	1.3	1.1
Nonmetropolitan residence, %	18.1	18.2	21.3	21.4
Residential zip code poverty, %	13.2	12.6	13.8	13.0
Medicare-Medicaid dually eligible, %	10.8	11.3	9.0	8.7
MCCs, %	2.8	2.9	2.6	2.9
MSAs	75	75	119	119
Hospitals	609	609	757	757
Episodes	35,498	119,319	48,366	151,678

AAPI, Asian American/Pacific Islander; CJR, Comprehensive Care for Joint Replacement Model; MCCs, major complications and comorbid conditions [diagnosis related group 469]; MJR, major joint replacement; MSA, metropolitan statistical area; PAC, postacute care; SNF, skilled nursing facility.

\*All statistics are calculated at the hospital level. *Pre-CJR* refers to period between July 2014 and June 2015 (before CJR was launched); *post CJR* refers to period between April 2016 and December 2018 (after the launch of CJR).

Source: Authors' calculations using Medicare, American Hospital Association, and American Community Survey data.

of HHC, and (3) emergency department visits without hospitalization within 60 days of the start of HHC. Next, we examined (4) the days between hospital discharge and the date that the patient received their first HHC visit. Finally, we examined (5) the distinct number of HHC agencies used by discharges of each hospital. An increase in (1) and a decrease in averages of (2), (3), and (4) suggest that the quality of the HHC used improved.<sup>23</sup> A decrease in (5) may be indicative of hospitals establishing preferred HHC networks, leading to patients in fewer agencies. All outcomes are further described in [eAppendix 3](#).

## Subgroups

We were also interested in whether CJR may have affected racial/ethnic populations differently. We used the Research Triangle Institute race codes, contained in Medicare enrollment data, to identify patients who were non-Hispanic White (hereafter, "White"), non-Hispanic Black (hereafter, "Black"), Hispanic, and AAPI.

## Statistical Analysis

We used a hospital-level linear probability model with a difference-in-differences design to estimate the effects of CJR on uptake rates, comparing hospitals in treatment and control MSAs before the announcement of CJR (July 2014–June 2015) and after CJR's implementation (April 2016–December 2018) ([eAppendix 4](#)). We included 2018 data (when CJR became voluntary) and thus conducted an intent-to-treat analysis similar to prior literature.<sup>15,16</sup>

## Sensitivity Analysis

We also conducted several robustness checks, including assessing for violations of parallel pretrends in outcomes for a difference-in-differences approach ([eAppendix Figures 1–5](#)); restricting our sample to hospitals with at least 10 discharges to HHC in both the pre- and posttreatment periods ([eAppendix Table 2](#)); restricting our sample to the first 2 years of CJR when the program was mandatory ([eAppendix Table 3](#)); examining the effects of CJR on intervening events (ie, institutionalization, death [there were no decedents]) that may prevent uptake of HHC ([eAppendix Table 4](#)); and examining effects on unadjusted uptake rates ([eAppendix Table 5](#)). Robustness checks indicated similar results, although estimates for AAPI patients should be interpreted with caution ([eAppendix Figure 5](#)) given the potential violation of the parallel pretrends assumption.

## RESULTS

We first show unadjusted, descriptive statistics of the analytic sample at the hospital level, comparing treatment and control groups before and after CJR. Prior to CJR, treatment and control groups were similar, indicative of successful randomization, although there were some slight differences that make it appropriate to control for group-level differences via approaches such as difference-in-differences ([Table 1](#) and [eAppendix Table 6](#)). CJR hospitals performed slightly fewer joint replacement episodes per month before vs after CJR (13.6 vs 15.3,

respectively). During baseline, treatment and control hospitals had similar referral rates to HHC agencies (31.6% vs 31.9%). HHC referrals were similar clinically and demographically. However, CJR hospitals had a slightly lower rate of unadjusted uptake (83.9% vs 85.5%).

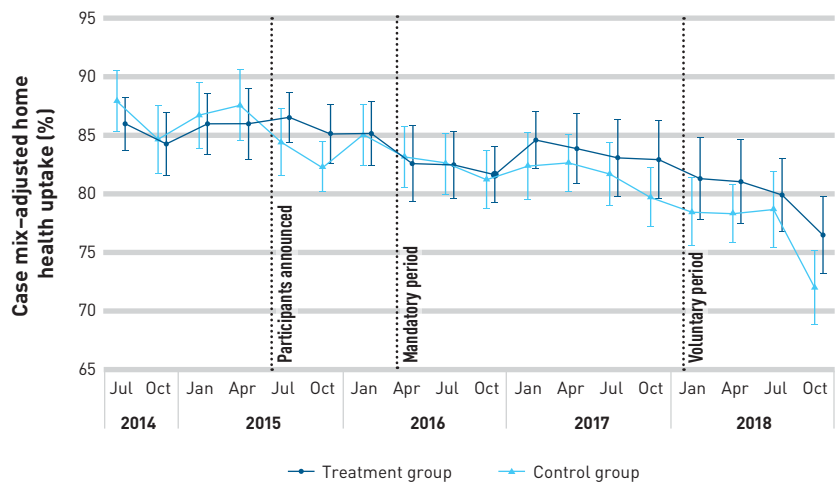
Descriptive statistics also suggest that hospitals increasingly referred patients to HHC and that the composition of referrals changed over time (Table 1). Referrals to HHC at control group hospitals increased from 31.9% to 35.6%, which was slightly lower than but similar to the increase among CJR hospitals (31.6% to 38.2%). HHC referrals under CJR were more likely for racial/ethnic minority groups and patients who were dually eligible for Medicare and Medicaid. Moreover, patients without use of hospital or institutional postacute care (ie, skilled nursing facility, inpatient rehabilitation, long-term care hospital) in the last half-year before receiving joint replacement surgery became a smaller share of those with referrals to HHC after CJR (Table 1). Patterns for patients referred to HHC were similar to patterns for the overall joint replacement patients (eAppendix Table 7).

**Figure 1** compares trends in HHC uptake rates, separately for treatment and control groups, in quarterly increments. Both treatment and control groups had similar uptake rates in the year before CJR participants were announced. The treatment and control groups diverged during the period between the date of announcement and implementation. In the 3 program years following CJR implementation, estimated rates were initially nearly identical between treatment and control during the first program year, followed by a gap between treatment and control hospitals.

**Figure 2** shows unadjusted HHC uptake at the MSA level before CJR (panel A) and the within-MSA change after CJR (panel B). Unadjusted uptake rates ranged from 51.06% in Rochester, New York, to 98.7% in Beaumont–Port Arthur, Texas, in the period before CJR. The largest improvement in HHC uptake was 18.9 percentage points and the largest decline was 22.9 percentage points.

**Table 2** shows means and mean differences before and after CJR within treatment and control groups as well as the regression-derived difference-in-differences estimates. Prior to CJR, a comparison of case mix–adjusted means indicated that the overall HHC uptake rate among treatment hospitals (83.59%) was lower than in control hospitals (85.34%) (Table 2). After CJR, mean case mix–adjusted uptake rates decreased for both treatment (81.26%) and control (79.17%) groups. Regression estimates indicate that CJR was associated with a 3.73–percentage point differential increase (95% CI, 0.97–6.49;  $P = .008$ ) in HHC uptake rates among patients referred to HHC (Table 2).

**FIGURE 1.** Quarterly Trends in Case Mix–Adjusted Uptake Rates of Prescribed Home Health Care<sup>a</sup>



CJR, Comprehensive Care for Joint Replacement Model; MSA, metropolitan statistical area.

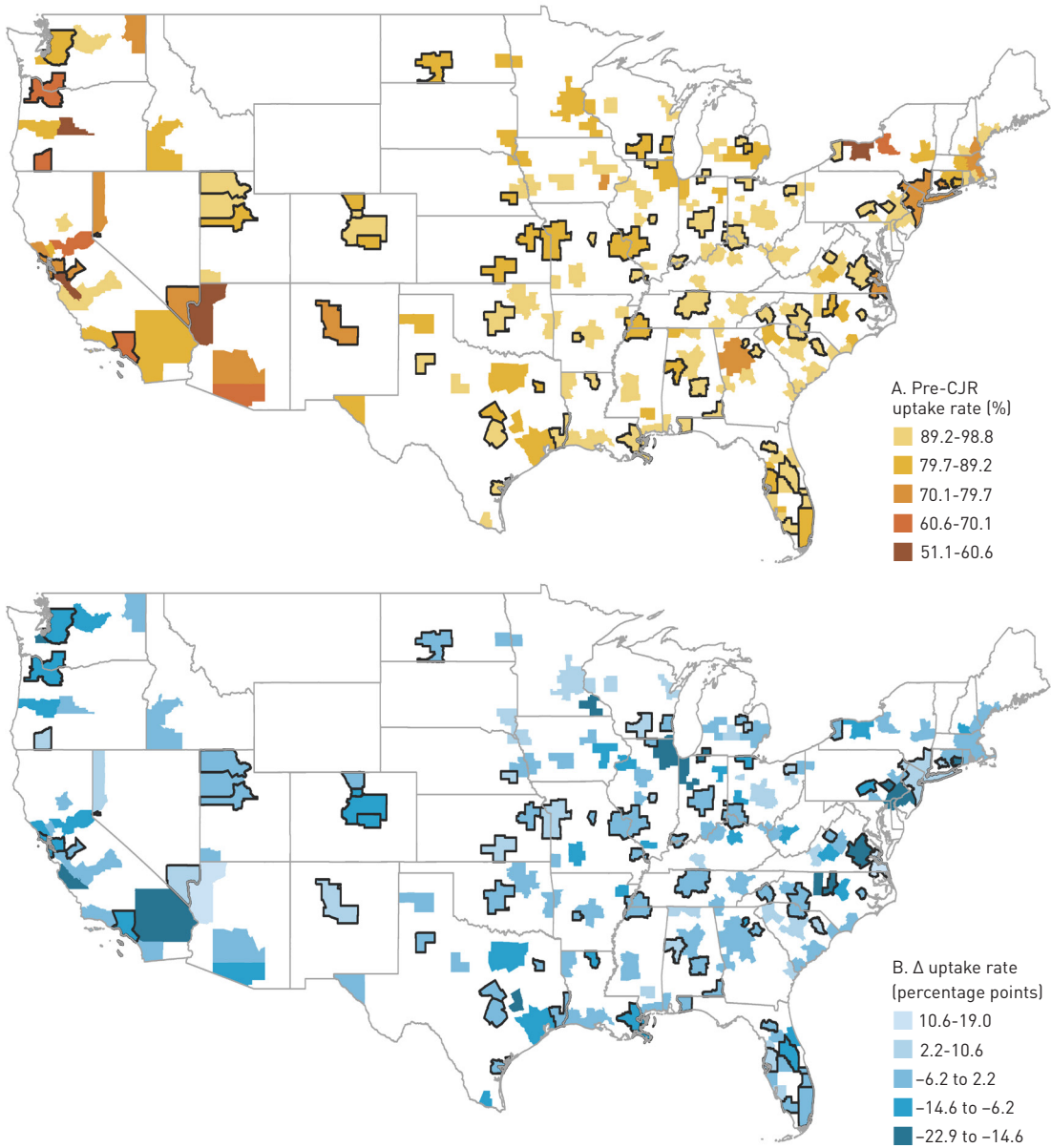
<sup>a</sup>Discharges between July 2015 and March 2016 were excluded from regression analyses. January 2018 marked the end of the mandatory CJR participation for hospitals in randomly selected MSAs. Estimates and 95% CIs were calculated using each cross section of data. All CIs were clustered at the MSA level. For the treatment group, monthly referrals to home health care averaged 11,656 before CJR (July 2014–June 2015), 12,823 during the mandatory period (April 2016–December 2017), and 11,394 during the voluntary period (2018). For the control group, monthly referrals to home health care averaged 8050 before CJR (July 2014–June 2015), 8808 during the mandatory period (April 2016–December 2017), and 8295 during the voluntary period (2018).

Source: Authors' calculations using Medicare data.

The regression results also indicate that the effects of CJR on uptake rates differentially improved by 3.54 percentage points for White individuals (95% CI, 0.42–6.65;  $P = .026$ ). There was a marginally statistically significant improvement of 5.05 percentage points for Black individuals (95% CI, –0.09 to 10.18;  $P = .054$ ) due to worsened uptake for the control group rather than improved uptake for the treatment group. In contrast, point estimates were small, negative, and not statistically significant for Hispanic (–0.82; 95% CI, –6.18 to 4.54;  $P = .763$ ) and AAPI (–0.48; 95% CI, –10.18 to 9.22;  $P = .922$ ) populations.

For patients who received HHC upon referral, there was modest suggestive evidence that hospitals discharged patients to higher-quality agencies under CJR (Table 3). The differential effect estimate for days to first HHC visit was –0.04 days (95% CI, –0.12 to 0.04;  $P = .337$ ), and estimates for agency scores for walking improvements (0.32 with control average of 65.21%; 95% CI, –0.38 to 1.03;  $P = .365$ ), emergency department visits (–0.12 with control average of 12.52%; 95% CI, –0.35 to 0.11;  $P = .300$ ), and hospitalizations (–0.11 with control average of 16.16%; 95% CI, –0.38 to 0.15;  $P = .397$ ) were all in directions consistent with greater use of higher-quality HHC agencies, but none were statistically significant. There was also no indication that the number of agencies used had changed. These patterns were qualitatively similar for White and Black populations but not for Hispanic or AAPI populations, for whom the patterns were mixed.

**FIGURE 2.** Uptake Rates of Prescribed Home Health Care Across Treatment and Control Groups in the CJR Model<sup>a</sup>



CJR, Comprehensive Care for Joint Replacement Model; MSA, metropolitan statistical area.

<sup>a</sup>*Pre-CJR period* refers to July 2014 through June 2015; *post-CJR period* refers to April 2016 through December 2018. MSAs randomly selected for treatment in CJR are outlined in black. Panel A shows pre-CJR rates (%). Panel B shows the change in uptake rates (percentage points) within each MSA between post and pre-CJR. See eAppendix Figure 6 for a display of panel B separately for treatment and control MSAs.

Source: Authors' calculations using Medicare data.

## DISCUSSION

From April 2016 through December 2018, 79.17% of patients discharged after joint replacement surgery who were referred to HHC received it. During CJR, uptake of HHC decreased but the decrease was

mitigated for patients at CJR hospitals, resulting in a differential of 3.73 percentage points in HHC uptake, or a 4.5% improvement in postacute HHC adherence. Uptake rates decreased less for White (3.54–percentage point differential) and Black (5.05–percentage point

**TABLE 2.** Case Mix–Adjusted Uptake Rates (%) of Prescribed Home Health Care\*

Rates	Total	White patients	Black patients	Hispanic patients	AAPI patients
<b>Treatment</b>					
Pre-CJR, mean	83.59	83.76	85.24	89.27	90.04
Post CJR, mean	81.26	79.69	85.92	82.72	80.66
Difference	-2.33	-4.07	0.68	-6.55	-9.38
<b>Control</b>					
Pre-CJR, mean	85.34	85.86	85.65	87.20	87.76
Post CJR, mean	79.17	78.19	81.24	81.25	79.22
Difference	-6.18	-7.67	-4.40	-5.95	-8.54
<b>DID</b>					
Estimate	3.73	3.54	5.05	-0.82	-0.48
95% CI	0.97-6.49	0.42-6.65	-0.09 to 10.18	-6.18 to 4.54	-10.18 to 9.22
MSAs, n	194	194	150	142	101
Hospitals, n	2732	2616	1334	1266	608

AAPI, Asian American/Pacific Islander; CJR, Comprehensive Care for Joint Replacement Model; DID, difference-in-differences; MSA, metropolitan statistical area.

\*Uptake rates are adjusted for hospitalization characteristics, patient demographics and residential characteristics, and quarter and year indicators. *Pre-CJR* refers to period between July 2014 and June 2015 (before CJR was launched); *post CJR* refers to period between April 2016 and December 2018 (after the launch of CJR). SEs are clustered at the MSA level.

Source: Authors' calculations using Medicare data.

**TABLE 3.** Difference-in-Differences Estimates of Effects of CJR on the Type of Home Health Care Received by Patients\*

Measures	Total	White patients	Black patients	Hispanic patients	AAPI patients
<b>Ambulation (%)</b>					
Mean	65.21	65.37	65.77	65.17	65.33
Estimate	0.32	0.41	0.01	0.75	-0.14
95% CI	-0.38 to 1.03	-0.30 to 1.12	-1.30 to 1.31	-0.61 to 2.10	-1.83 to 1.55
<b>Hospitalizations (%)</b>					
Mean	16.16	16.17	16.19	15.94	15.63
Estimate	-0.11	-0.08	-0.13	0.12	-0.44
95% CI	-0.38 to 0.15	-0.34 to 0.17	-0.62 to 0.36	-0.31 to 0.55	-1.14 to 0.27
<b>ED visits (%)</b>					
Mean	12.52	12.54	12.25	12.05	11.83
Estimate	-0.12	-0.16	-0.37	0.28	0.23
95% CI	-0.35 to 0.11	-0.39 to 0.08	-0.70 to -0.04	-0.13 to 0.69	-0.41 to 0.87
<b>Days to visit (n)</b>					
Mean	1.46	1.42	1.48	1.35	1.38
Estimate	-0.04	-0.02	-0.10	0.09	-0.15
95% CI	-0.12 to 0.04	-0.09 to 0.04	-0.27 to 0.06	-0.06 to 0.25	-0.39 to 0.08
<b>Agencies (n)</b>					
Mean	12.19	11.65	3.39	2.82	2.14
Estimate	0.65	0.56	-0.05	0.47	0.00
95% CI	-0.79 to 2.09	-0.77 to 1.90	-0.57 to 0.47	-0.13 to 1.07	-0.78 to 0.78
MSAs, n	194	194	149	137	93
Hospitals, n	2664	2538	1238	1168	550

AAPI, Asian American/Pacific Islander; CJR, Comprehensive Care for Joint Replacement Model; ED, emergency department; MSA, metropolitan statistical area.

\*Ambulation, hospitalizations, and ED visits are home health agency-level quality measures of each agency's percentage of patients with improved ambulation, hospitalization rates, and ED visit rates, respectively (more information available from CareCompare.com). *Days to visit* refers to the mean number of days between hospital discharge and the first home health visit among patients who received home health as prescribed. *Agencies* refer to the number of distinct home health agencies used by home health care patients of each hospital. SEs are clustered at the MSA level.

Source: Authors' calculations using Medicare data.

differential) patients, which were also the populations with the lowest uptake rates prior to CJR. We observed modest and statistically insignificant effects of CJR on the types of HHC agencies used. Bundled payment incentives likely improved quality by increasing patients' uptake of prescribed postacute HHC, but more work is needed to ensure HHC access for large portions of the population, especially Hispanic and AAPI individuals.

Prior studies' findings have convincingly shown that CJR increased use of HHC,<sup>13-16</sup> but they have not clarified whether CJR improved patient adherence to these new referral practices. Our study builds upon this knowledge by documenting that, at least in terms of patient adherence to HHC referrals, hospitals may have improved quality. Moreover, although noisily estimated, improvements in uptake rates were particularly large for Black individuals discharged from CJR hospitals, effectively making uptake rates the highest among Black individuals compared with all other racial/ethnic groups. However, this relative improvement appears to be driven by a decline in the uptake rates for Black patients in the control hospitals over the time period. These data suggest that CJR may have had beneficial effects for both quality improvement and health equity. Nonetheless, even with higher uptake of HHC under CJR, our results show that 15% to 20% of referrals do not result in receipt of HHC, which is in line with prior estimates,<sup>8,24</sup> highlighting substantial room for improvement.

Determining why HHC uptake is low is difficult due to both demand- and supply-side reasons for nonadherence. On the supply side, HHC worker numbers fell by nearly 12% from 2013 to 2019.<sup>25</sup> Thus, HHC agencies may have faced capacity constraints in meeting the volume of referrals from joint replacement discharges. On the demand side, our findings are consistent with explanations put forth in the literature, such as patients avoiding suboptimal HHC experiences, fearing loss of privacy and autonomy, and wanting to expedite their return to the community.<sup>10</sup>

Study findings suggest that actively involving patients and their caregivers in addressing concerns and explaining the value of postacute HHC might mitigate unrealistic patient expectations of recovery, potentially increasing their willingness to accept HHC assistance.<sup>10</sup> Particularly if care is to be delivered at home, establishing trust between the health care team and patients requires explicit investment in understanding patient concerns.<sup>26</sup> For patients concerned about negative experiences with HHC, for instance, providers may need to be more engaged in helping them identify higher-quality HHC.<sup>11</sup>

Studies have also found that patient adherence is related to how physicians communicate with patients, with better outcomes when patients are actively involved and there are open discussions of barriers to adherence.<sup>2,27</sup> Our null results for Hispanic and AAPI individuals, for whom language barriers are more prevalent, suggest a need for more effective communication among providers, patients, and caregivers. Nearly 40% of hospitals do not offer language services,<sup>28</sup> and approximately one-third of HHC aides report speaking a different language than their patients.<sup>29</sup> As a structural barrier to health care,<sup>30</sup> language-induced barriers may

erode trust<sup>31</sup> and lower patients' willingness to let care providers complete medically necessary tasks.<sup>32</sup> Our study results point to a need for future research to better understand the reasons for low HHC uptake.

### Limitations

Our study has limitations. First, although we adjusted for the case mix of patients referred to HHC using established risk adjustment methods, prediction models are imperfect and limited by observables. Thus, our estimated effects of CJR on uptake may also reflect changes in patient composition rather than CJR interventions. Second, we used the discharge destination code in inpatient claims data to identify referrals to HHC, consistent with prior literature.<sup>8,9,19</sup> Although hospital discharge planners populate this field based on their assessment of patient needs for postdischarge care, care arrangements may change after discharge and not all hospitals update the destination code.<sup>24</sup> Therefore, the discharge destination code is a proxy for referrals and may contain errors. If CJR hospitals are differentially more likely to update discharge destination codes, then our estimate of the CJR's effect on uptake may be biased upward. However, uptake rates for all groups, except for Black individuals, trended down, which is inconsistent with CJR hospitals more systematically and retroactively correcting documentation. Finally, we cannot extend our results beyond the hospitals in MSAs included in the original study design, which served a greater proportion of urban patients.

## CONCLUSIONS

These limitations notwithstanding, this is the first study to examine the impact of bundled payment incentives on HHC uptake rates. Although we observed improved HHC uptake in CJR hospitals compared with controls, the potential impact varied by race and ethnicity and was modest, especially when considering the share of patients who do not receive HHC as prescribed. With HHC and the home environment becoming increasingly important as a site of care for aging adults, it remains a puzzle why sizeable proportions of patients miss out on these services. Future work is urgently needed to uncover how structural factors can be modified to alleviate patients' concerns and decrease barriers to recommended care. ■

**Author Affiliations:** Maxwell School of Citizenship and Public Affairs, Syracuse University (JL), Syracuse, NY; Labovitz School of Business and Economics, University of Minnesota Duluth (LL), Duluth, MN.

**Source of Funding:** This research was supported in part with a Health Services Research Grant (AOTFHSR21LI) to Dr Li funded by the American Occupational Therapy Foundation. The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

**Prior Presentation:** This work was presented at the American Society for Health Economists Annual Conference in 2023 and Association for Public Policy Analysis and Management Annual Meeting in 2023.

**Author Disclosures:** The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

**Authorship Information:** Concept and design (JL, LL); acquisition of data (JL); analysis and interpretation of data (JL, LL); drafting of the manuscript (JL, LL); critical revision of the manuscript for important intellectual content (JL, LL); statistical analysis (JL); obtaining funding (JL); administrative, technical, or logistic support (JL); and supervision (JL).

**Address Correspondence to:** Jun Li, PhD, Maxwell School of Citizenship and Public Affairs, Syracuse University, 314 Lyman Hall, Room 320E, Syracuse, NY 13244. Email: jli208@syr.edu.

## REFERENCES

- Salisbury KR, Ranpariya VK, Feldman SR. Accountability in reminder-based adherence interventions: a review. *Patient Educ Couns*. 2022;105(8):2645-2652. doi:10.1016/j.pec.2021.12.009
- Haskard Zolnierok KB, DiMatteo MR. Physician communication and patient adherence to treatment: a meta-analysis. *Med Care*. 2009;47(8):826-834. doi:10.1097/MLR.0b013e31819a5acc
- Luga AO, McGuire MJ. Adherence and health care costs. *Risk Manag Healthc Policy*. 2014;7:35-44. doi:10.2147/RMHP.S19801
- Cutler RL, Fernandez-Llamos F, Frommer M, Benrimoj C, Garcia-Cardenas V. Economic impact of medication non-adherence by disease groups: a systematic review. *BMJ Open*. 2018;8(1):e016982. doi:10.1136/bmjopen-2017-016982
- Topaz M, Kang Y, Holland DE, Ohta B, Rickard K, Bowles KH. Higher 30-day and 60-day readmissions among patients who refuse post acute care services. *Am J Manag Care*. 2015;21(6):424-433.
- Home health services. Medicare.gov. Accessed January 29, 2023. <https://www.medicare.gov/coverage/home-health-services>
- Werner RM, Bressman E. Trends in post-acute care utilization during the COVID-19 pandemic. *J Am Med Dir Assoc*. 2021;22(12):2496-2499. doi:10.1016/j.jamda.2021.09.001
- Loomer L, Kosar CM, Meyers DJ, Thomas KS. Comparing receipt of prescribed post-acute home health care between Medicare Advantage and traditional Medicare beneficiaries: an observational study. *J Gen Intern Med*. 2021;36(8):2323-2331. doi:10.1007/s11606-020-06282-3
- Li J, Qi M, Werner RM. Assessment of receipt of the first home health care visit after hospital discharge among older adults. *JAMA Netw Open*. 2020;3(9):e2015470. doi:10.1001/jamanetworkopen.2020.15470
- Levine C, Lee T. "I Can Take Care of Myself!": Patients' Refusals of Home Health Care Services. United Hospital Fund; May 2017. Accessed May 24, 2023. [https://media.uhfnyc.org/filer\\_public/e6/9c/e69c0035-169d-4f52-94da-aec0fac7faa9/homecarerefusals-final-051517\\_1.pdf](https://media.uhfnyc.org/filer_public/e6/9c/e69c0035-169d-4f52-94da-aec0fac7faa9/homecarerefusals-final-051517_1.pdf)
- Li J, Jeffers T, Ogunjesa B, Raj M. Hospital discharge planners need more information when referring patients to home health care: insights from the coronavirus disease 2019 pandemic. *Health Serv Insights*. 2023;16:11786329231211093. doi:10.1177/11786329231211093
- CMS, HHS. Medicare program; hospital inpatient prospective payment systems for acute care hospitals and the long-term care hospital prospective payment system policy changes and fiscal year 2016 rates; revisions of quality reporting requirements for specific providers, including changes related to the electronic health record incentive program; extensions of the Medicare-dependent, small rural hospital program and the low-volume payment adjustment for hospitals. *Fed Regist*. 2015;80(158):49325-49886.
- Finkelstein A, Ji Y, Mahoney N, Skinner J. Mandatory Medicare bundled payment program for lower extremity joint replacement and discharge to institutional postacute care: interim analysis of the first year of a 5-year randomized trial. *JAMA*. 2018;320(9):892-900. doi:10.1001/jama.2018.12346
- 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
- Barnett ML, Wilcock A, McWilliams JM, et al. Two-year evaluation of mandatory bundled payments for joint replacement. *N Engl J Med*. 2019;380(3):252-262. doi:10.1056/NEJMsa18091010
- Meyers DJ, Kosar CM, Rahman M, Mor V, Trivedi AN. Association of mandatory bundled payments for joint replacement with use of postacute care among Medicare Advantage enrollees. *JAMA Netw Open*. 2019;2(12):e1918535. doi:10.1001/jamanetworkopen.2019.18535
- The Lewin Group Inc. *Provider Experiences Under the CMS Comprehensive Care for Joint Replacement Model: Case Studies from Three Mandatory Markets*. CMS; November 2020. Accessed May 24, 2023. <https://www.cms.gov/priorities/innovation/data-and-reports/2022/cjr-thirdannrpt-provider-experiences>
- Sood N, Shier VL, Nakata H, Iorio R, Lieberman JR. The impact of comprehensive care for joint replacement bundled payment program on care delivery. *J Arthroplasty*. 2019;34(4):609-612.e1. doi:10.1016/j.arth.2018.11.034
- Demiralp B, Speelman JS, Cook CM, et al. Incomplete home health care referral after hospitalization among Medicare beneficiaries. *J Am Med Dir Assoc*. 2021;22(5):1022-1028.e1. doi:10.1016/j.jamda.2020.11.039
- 2020 plan all-cause readmissions measure fact sheet. CMS. April 1, 2020. Accessed May 25, 2023. <https://www.hhs.gov/guidance/document/2020-plan-all-cause-readmissions-measure-fact-sheet>
- Toolkit for using the AHRQ quality indicators. Agency for Healthcare Research and Quality. January 2012. Updated March 2017. Accessed May 25, 2023. <https://www.ahrq.gov/patient-safety/settings/hospital/resource/qitool/index.html>
- Kansagara D, Englander H, Salanitro A, Kagen D, Theobald C, Kripalani S. *Risk Prediction Models for Hospital Readmission: A Systematic Review*. US Department of Veterans Affairs Health Services Research and Development Service; October 2011. Accessed May 25, 2023. <https://www.hsrd.research.va.gov/publications/esp/readmission.pdf>
- Home health quality measures. CMS. February 22, 2023. Accessed May 25, 2023. <https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HomeHealthQualityInits/Home-Health-Quality-Measures>
- Kim H, Grunditz JI, Meath THA, Quiñones AR, Ibrahim SA, McConnell KJ. Accuracy of hospital discharge codes in Medicare claims for knee and hip replacement patients. *Med Care*. 2020;58(5):491-495. doi:10.1097/mlr.0000000000001290
- Kreider AR, Werner RM. The home care workforce has not kept pace with growth in home and community-based services. *Health Aff (Millwood)*. 2023;42(5):650-657. doi:10.1377/hlthaff.2022.01351
- Stuck RE, Rogers WA. Supporting trust in home healthcare providers: insights into the care recipients' perspective. *Home Health Care Serv Q*. 2019;39(2):61-79. doi:10.1080/01621424.2019.1604462
- O'Connor AM, Légaré F, Stacey D. Risk communication in practice: the contribution of decision aids. *BMJ*. 2003;327(7417):736-740. doi:10.1136/bmj.327.7417.736
- Schiaffino MK, Nara A, Mao L. Language services in hospitals vary by ownership and location. *Health Aff (Millwood)*. 2016;35(8):1399-1403. doi:10.1377/hlthaff.2015.0955
- Weng SS, Landes SD. Culture and language discordance in the workplace: evidence from the National Home Health Aide Survey. *Gerontologist*. 2017;57(5):900-909. doi:10.1093/geront/gnw110
- Bridges AJ, Andrews AR III, Deen TL. Mental health needs and service utilization by Hispanic immigrants residing in mid-southern United States. *J Transcult Nurs*. 2012;23(4):359-368. doi:10.1177/1043659612451259
- Flores G. The impact of medical interpreter services on the quality of health care: a systematic review. *Med Care Res Rev*. 2005;62(3):255-299. doi:10.1177/1077558705275416
- Schouten BC, Meeuwesen L. Cultural differences in medical communication: a review of the literature. *Patient Educ Couns*. 2006;64(1-3):21-34. doi:10.1016/j.pec.2005.11.014

Visit [ajmc.com/link/89677](https://ajmc.com/link/89677) to download PDF and eAppendix



## Supplemental Materials

<b>eAppendix 1.</b> CJR experimental design	Page 2
<b>eAppendix 2.</b> Case-mix-adjusted uptake rate	Page 3
<b>eAppendix 3.</b> Measures used in the study	Page 4
<b>eAppendix 4.</b> Estimating equations	Page 6
<b>eAppendix Table 1.</b> Referral rates (percent) to various discharge destinations.	Page 7
<b>eAppendix Table 2.</b> Case-mix adjusted uptake rates of prescribed home health care, restricted to hospitals with at least 10 discharges in both periods before and after CJR.	Page 8
<b>eAppendix Table 3.</b> Case-mix adjusted uptake rates of prescribed home health care, 2014–2017.	Page 9
<b>eAppendix Table 4.</b> Differential effect of CJR on institutionalization among people referred to home health within 14 days of discharge.	Page 10
<b>eAppendix Table 5.</b> Unadjusted uptake rates of prescribed home health care, 2014–2018.	Page 11
<b>eAppendix Table 6.</b> Study sample differences in characteristics	Page 12
<b>eAppendix Table 7:</b> Descriptive statistics for MJR patients regardless of discharge destination	Page 13
<b>eAppendix Figure 1.</b> Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the full sample.	Page 14
<b>eAppendix Figure 2.</b> Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the White sample.	Page 15
<b>eAppendix Figure 3.</b> Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the Black sample.	Page 16
<b>eAppendix Figure 4.</b> Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the Hispanic sample.	Page 17
<b>eAppendix Figure 5.</b> Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the Asian American and Pacific Islander (AAPI) sample.	Page 18
<b>eAppendix Figure 6.</b> Changes in uptake rates of prescribed home health care by treatment and control groups in the Comprehensive Care for Joint Replacement program.	Page 19

## **eAppendix 1. CJR experimental design**

The Centers for Medicare and Medicaid Service (CMS) used a stratified design to randomly select 75 Metropolitan Statistical Areas (MSAs) from a total of 196 MSAs. CMS first divided MSAs into 8 strata based on historical spending levels. Because each stratum contained a different number of MSAs, MSAs were only randomly selected conditional on strata.<sup>11</sup> Official announcement of the chosen MSAs occurred in July 2015, eight months before the official implementation of the program. In November 2015, CMS further excluded eight MSAs in order to account for hospital participation in Bundled Payment for Care Improvement (BPCI), a precursor, voluntary bundled payment program.<sup>20</sup> In December 2017, CMS allowed subsets of hospitals (e.g., rural) and nearly half of MSAs and their respective hospitals to withdraw participation, henceforth making CJR a voluntary program.<sup>21</sup> All eligible hospitals within MSAs selected for CJR were mandated to participate in the program's first two years, which lasted from April 2016 through December 2017.

## **eAppendix 2. Case-mix-adjusted uptake rate**

Our case-mix-adjusted uptake rate is the ratio of observed to expected uptake counts, scaled by the average uptake rate in the control group following methods employed by the CMS<sup>22</sup> and Agency for Healthcare Research and Quality.<sup>23</sup> Observed uptake counts were the sum of total number of people who received home health care within 14 days of discharge of each hospital. Expected uptake counts were the sum of expected probabilities of receipt of home health of each hospital. Expected probabilities were calculated from non-CJR (i.e., pre-intervention, treatment MSAs and control MSAs) discharge data using logistic regression, where we predicted home health uptake probabilities as a function of 1) hospitalization characteristics (surgery with or without complications, day of the week of hospitalization), 2) patient demographics and residential characteristics (age, sex, race and ethnicity, comorbidities, used inpatient care or home health care in the 180 days prior to hospitalization, dually enrolled in Medicaid, non-metropolitan status of residential ZIP code, percent of residential ZIP code in poverty, whether the residential ZIP code had low quality home health agencies, number of home health agencies and skilled nursing facilities in MSA of discharging hospital), and 3) quarter and year indicators. We selected these predictors using log-likelihood values and Akaike Information Criterion. Using weights obtained from this regression, we then calculated total expected uptake counts for each hospital and for each period before and after CJR. The overall C statistic of the prediction model was 0.67, comparable to published and widely used hospital-readmissions-risk-prediction models.<sup>24</sup>

### **eAppendix 3. Measures used in the study**

#### **Primary outcomes:**

1. Home health care referrals: Comes from the Discharge Destination Code from the MedPAR, in which the code indicates the destination of the beneficiary upon discharge from a hospital.
2. Home health care uptake: Receipt of a home health care visit as indicated in OASIS data in the 14 days following hospital discharge.

#### **Secondary outcomes:**

1. Improved Ambulation between end and start of home health care: Percentage of home health quality episodes during which the patient improved in ability to ambulate based on walking abilities assessed at admission and discharge. The agency-level measure is aggregated according to each hospital's home health care patient's agency used. OASIS based, calculated by CMS, and available from Care Compare.
2. Unplanned hospitalizations within 60 days of start of home health care: Percentage of home health stays in which patients were admitted to an acute care hospital during the 60 days following the start of the home health stay. Planned hospitalizations are based on the AHRQ Procedure and Condition CCS and certain ICD procedure codes (see <https://hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp>). The agency-level measure is aggregated according to each hospital's home health care patient's agency used. Claims-based, calculated by CMS, and available from Care Compare.
3. Emergency department visits without hospitalization within 60 days of start of home health care: Percentage of home health stays in which patients used the emergency department but were not admitted to the hospital during the 60 days following the start of home health stay. The agency-level measure is aggregated according to each hospital's home health care patient's agency used. Claims-based, calculated by CMS, and available from Care Compare.

Full documentation of Care Compare measures are available from CMS:

<https://www.cms.gov/files/document/home-health-outcome-measures-table-oasis-e2024.pdf>

4. Days between hospital discharge and first home health care visit: The number of days between hospital discharge and date of first home health care visit as documented on OASIS data.
5. Number of home health agencies: The number of distinct home health agencies used by each hospital's patients referred to home health care.

#### **Sensitivity analysis measures:**

1. Intervening events which may prevent uptake of home health care: Occurrence of a skilled nursing facility, inpatient rehabilitation, long-term care facility admission as indicated by MedPAR data, or death in the 14 days following hospital discharge as indicated by the MBSF. Note, however, that there were 0 deaths in the 14 days following hospital discharge in the sample.

#### **Other measures:**

1. Referrals to home without home health care: Comes from the Discharge Destination Code from the MedPAR, in which the code indicates the destination of the beneficiary upon discharge from a hospital.
2. Referrals to skilled nursing facility: Comes from the Discharge Destination Code from the MedPAR, in which the code indicates the destination of the beneficiary upon discharge from a hospital.
3. Referrals to institutional post-acute care facilities: Comes from the Discharge Destination Code from the MedPAR, in which the code indicates the destination of the beneficiary upon discharge from a hospital. This measure includes destinations of skilled nursing facilities, inpatient rehabilitation facilities, and long-term care hospitals.

#### eAppendix 4. Estimating equations

$$y_{jt} = \delta Treated_{jt} + \mu_j + \lambda_t + \epsilon_{jt},$$

Where  $j$  indexes hospital,  $t$  indexes period and takes on the value of 0 if a discharge occurred between July 2014 and June 2015 and 1 if a discharge occurred between April 2016 and December 2018.  $y_{jt}$  is outcome of interest, including uptake rate, days to first home health visit, average mix of agencies used in terms of percent of patients with improved walking abilities between end and start of home health care, average mix of agencies used in terms of percent of home health patients with 60-day hospitalization since start of home health care, and average mix of agencies used in terms of percent of home health patients with 60-day emergency department visits since start of home health care.  $Treated_{jt}$  is a binary indicator variable that takes on a value of 1 for after CJR is started and 0 otherwise.  $\mu_j$  are dummy variables for hospital,  $\lambda_t$  are dummy variables for performance years. These hospital and period fixed effects capture time-invariant hospital characteristics and secular changes before and after CJR. Because MSAs had unequal probability of being selected for treatment, we weighted all analyses using standardizing weights to reproduce conditional randomization.<sup>15</sup>  $\hat{\delta}$  provides the estimated, intent-to-treat treatment effect.

**eAppendix Table 1.** Referrals rates (percent) to various discharge destinations.

	HHC	Home	SNF	Institutional
<b>Treatment</b>				
Pre, mean	31.62	16.52	39.53	50.23
Post, mean	38.15	23.15	31.28	37.88
Difference	6.53	6.63	-8.25	-12.35
<b>Control</b>				
Pre, mean	31.85	18.96	36.15	47.91
Post, mean	35.57	24.88	29.42	38.69
Difference	3.71	5.91	-6.73	-9.22
<b>DiD</b>				
Estimate	2.82	0.72	-1.51	-3.13
95% CI	(-0.66 , 6.29)	(-1.93 , 3.36)	(-3.64 , 0.61)	(-5.18 , -1.08)
MSAs (N)	194	194	194	194
Hospitals (n)	2,732	2,732	2,732	2,732

**Source:** Authors' calculations using Medicare data.

**Notes:** HHC: Home health care. SNF: Skilled nursing facility. DID: Difference-in-differences estimate. "Home" refers to home without home health care. "Institutional" includes skilled nursing facilities, inpatient rehabilitation facilities, and long-term care hospitals. Referral rates are based on discharge destination on the inpatient claim. Pre refers to period between July 2014 and June 2015 (before CJR); Post refers to period between April 2016 and December 2018 (after CJR). Standard errors are clustered at the MSA level.

**eAppendix Table 2.** Case-mix adjusted uptake rates of prescribed home health care, restricted to hospitals with at least 10 discharges in both periods before and after CJR.

	Full	White	Black	Hispanic	AAPI
<b>Treatment</b>					
Pre, mean	85.93	86.29	85.66	84.88	80.01
Post, mean	82.26	81.78	84.36	81.56	70.94
Difference	-3.67	-4.51	-1.30	-3.32	-9.07
<b>Control</b>					
Pre, mean	86.41	86.64	86.56	83.68	75.59
Post, mean	79.63	78.86	81.47	77.68	71.38
Difference	-6.78	-7.79	-5.09	-6.00	-4.21
<b>DiD</b>					
Estimate	3.07	3.26	3.74	2.50	-5.25
95% CI	(0.42, 5.72)	(0.59, 5.94)	(-2.5, 10.08)	(-5.45, 10.46)	(-33.05, 22.55)
MSAs (N)	188	188	49	31	6
Hospitals (n)	1,974	1,876	176	106	22

**Source:** Authors' calculations using Medicare data.

**Notes:** AAPI = Asian Americans and Pacific Islander, DID = Difference-in-differences estimate. Take-up rates are adjusted for hospitalization characteristics, patient demographics and residential characteristics, and quarter and year indicators. Pre refers to period between July 2014 and June 2015 (before CJR); Post refers to period between April 2016 and December 2018 (after CJR). Standard errors are clustered at the MSA level.



**eAppendix Table 3.** Case-mix adjusted uptake rates of prescribed home health care, 2014–2017.

	Full	White	Black	Hispanic	AAPI
<b>Treatment</b>					
Pre, mean	83.76	84.12	84.94	90.50	90.17
Post, mean	82.32	80.98	85.78	86.67	83.25
Difference	-1.45	-3.14	0.85	-3.83	-6.92
<b>Control</b>					
Pre, mean	85.39	86.15	85.54	86.91	88.04
Post, mean	80.95	80.13	81.76	84.62	82.71
Difference	-4.44	-6.02	-3.79	-2.30	-5.33
<b>DiD</b>					
Estimate	2.85	2.82	4.67	-1.98	-1.05
95% CI	(0.23, 5.47)	(-0.17, 5.80)	(-0.50, 9.85)	(-7.50, 3.54)	(-9.78, 7.69)
MSAs (N)	194	194	148	138	94
Hospitals (n)	2,714	2,594	1,268	1,204	562

**Source:** Authors' calculations using Medicare data.

**Notes:** AAPI = Asian Americans and Pacific Islander, DID = Difference-in-differences estimate. Take-up rates are adjusted for hospitalization characteristics, patient demographics and residential characteristics, and quarter and year indicators. Pre refers to period between July 2014 and June 2015 (before CJR); Post refers to period between April 2016 and December 2017 (after CJR). Standard errors are clustered at the MSA level.

**eAppendix Table 4.** Differential effect of CJR on institutionalization among people referred to home health within 14 days of discharge.

	Full	White	Black	Hispanic	AAPI
<b>Treatment</b>					
Pre, mean	4.39	4.12	5.13	4.46	3.75
Post, mean	4.33	4.31	4.48	2.96	3.00
Difference	-0.06	0.18	-0.66	-1.50	-0.75
<b>Control</b>					
Pre, mean	4.45	4.40	5.74	3.91	2.96
Post, mean	4.63	4.74	4.88	2.97	4.77
Difference	0.18	0.33	-0.86	-0.94	1.81
<b>DiD</b>					
Estimate	-0.23	-0.16	0.14	-0.51	-2.38
95% CI	(-1.15, 0.69)	(-1.27, 0.95)	(-2.94, 3.21)	(-2.75, 1.73)	(-6.83, 2.07)
MSAs (N)	194	194	150	142	101
Hospitals (n)	2,732	2,616	1,338	1,266	624

**Source:** Authors' calculations using Medicare data.

**Notes:** AAPI = Asian Americans and Pacific Islander, DID = Difference-in-differences estimate.

Institutionalization included hospital, skilled nursing facility, inpatient rehabilitation, or long-term care hospital use, and is calculated using MedPAR data. There were no decedents in the 14 days of discharge among people referred to home health care (calculated using Medicare enrollment file indicating date of death). Pre refers to period between July 2014 and June 2015 (before CJR); Post refers to period between April 2016 and December 2018 (after CJR). Standard errors are clustered at the MSA level.

**eAppendix Table 5.** Unadjusted uptake rates of prescribed home health care, 2014–2018.

	Full	White	Black	Hispanic	AAPI
<b>Treatment</b>					
Pre, mean	83.62	83.67	84.94	86.65	86.51
Post, mean	83.01	82.22	84.99	82.86	79.71
Difference	-0.61	-1.45	0.05	-3.79	-6.80
<b>Control</b>					
Pre, mean	85.50	85.81	86.14	85.37	82.74
Post, mean	80.94	80.61	81.67	80.57	78.91
Difference	-4.56	-5.20	-4.47	-4.80	-3.83
<b>DiD</b>					
Estimate	3.87	3.73	4.57	0.73	-2.47
95% CI	(1.13, 6.61)	(0.54, 6.91)	(-0.5, 9.65)	(-4.78, 6.23)	(-11.44, 6.51)
MSAs (N)	194	194	150	142	101
Hospitals (n)	2,732	2,616	1,338	1,266	624

**Source:** Authors' calculations using Medicare data.

**Notes:** AAPI = Asian Americans and Pacific Islander, DID = Difference-in-differences estimate. Pre refers to period between July 2014 and June 2015 (before CJR); Post refers to period between April 2016 and December 2018 (after CJR). Standard errors are clustered at the MSA level.

**eAppendix Table 6.** Study sample differences in characteristics

	Treatment			Control		
	Pre	Post	Diff	Pre	Post	Diff
<b>Hospital characteristics</b>						
Teaching, %	42.4	42.4	0	39.6	39.6	0
Safety-net, %	23.8	23.8	0	20.4	20.4	0
For-profit, %	20.5	20.5	0	20.6	20.6	0
Beds, %	269.2	269.2	0	251.0	251.0	0
Physician integration, %	59.9	59.9	0	57.7	57.7	0
Home health integration, %	40.0	40.0	0	36.1	36.1	0
SNF integration, %	69.2	69.2	0	65.9	65.9	0
<b>MJR characteristics</b>						
MJRs per hospital per month, n	13.6	14.5	-0.9	15.3	16.1	-0.8
Home health referrals per hospital, %	31.6	38.2	-6.6	31.9	35.6	-3.7
Home health take up per hospital, %	83.9	83.1	0.8	85.5	80.9	4.6
<b>Patient demographics</b>						
Age, y	73.1	73.6	-0.5	72.9	73.4	-0.5
Female, %	60.5	63.4	-2.9	59.5	62.5	-3
White, %	83.0	82.7	0.3	84.4	85.2	-0.8
Black, %	5.7	5.9	-0.2	6.1	6.1	0
Hispanic, %	6.7	6.6	0.1	6.1	4.9	1.2
AAPI, %	2.2	2.2	0	1.4	1.4	0
Elixhauser, n	2.1	2.2	-0.1	2.1	2.2	-0.1
Hospitalized 180 days prior, %	9.6	8.0	1.6	9.1	8.0	1.1
Home health use 180 days prior, %	8.2	7.2	1	7.9	7.1	0.8
Institutional PAC use 180 days prior, %	1.3	1.1	0.2	1.3	1.1	0.2
Non-metro residence, %	18.1	18.2	-0.1	21.3	21.4	-0.1
Residential ZIP poverty, %	13.2	12.6	0.6	13.8	13.0	0.8
Medicare-Medicaid dually eligible, %	10.8	11.3	0.5	9.0	8.7	0.3
DRG 469, %	6.2	6.5	0.3	5.9	5.9	0
MSAs	75	75		119	119	
Hospitals	609	609		757	757	
Episodes	35,498	119,319		48,366	151,678	

**Source:** Authors' calculations using Medicare, American Hospital Association, and American Community Survey data.

**Notes:** All statistics are calculated at the hospital level. Pre refers to period between July 2014 and June 2015 (before CJR); Post refers to period between April 2016 and December 2018 (after CJR). SNF: Skilled Nursing Facility; MJR: Major Joint Replacement, AAPI: Asian American Pacific Islander; PAC: Post-acute Care; DRG 469: Major hip and knee joint replacement or reattachment of lower extremity with major complications and comorbid conditions or total ankle replacement; MSA: Metropolitan Statistical Area. CJR: Comprehensive Care for Joint Replacement.

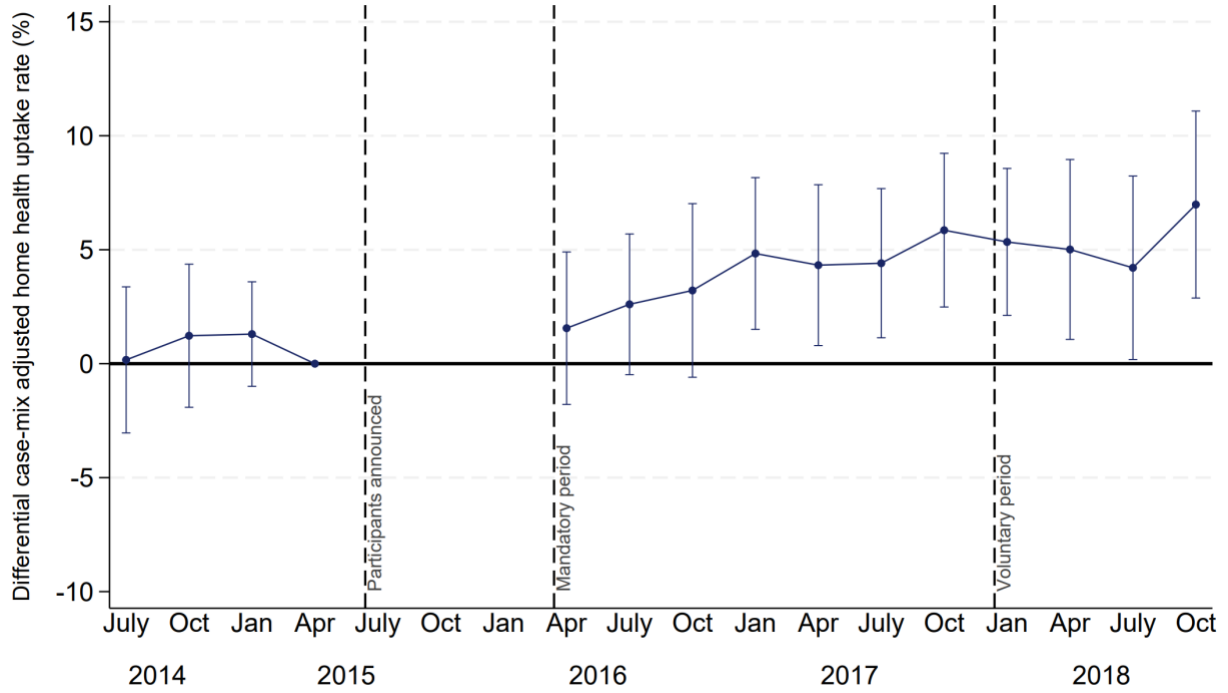
**eAppendix Table 7.** Descriptive statistics for MJR patients regardless of discharge destination

	Treatment		Control	
	Pre	Post	Pre	Post
<b>Hospital characteristics</b>				
Teaching, %	42.4	42.4	39.6	39.6
Safety-net, %	23.8	23.8	20.4	20.4
For-profit, %	20.5	20.5	20.6	20.6
Beds, %	269.2	269.2	251.0	251.0
Physician integration, %	59.9	59.9	57.7	57.7
Home health integration, %	40.0	40.0	36.1	36.1
SNF integration, %	69.2	69.2	65.9	65.9
<b>MJR characteristics</b>				
MJRs per hospital per month, n	13.6	14.5	15.3	16.1
Home health referrals per hospital, %	31.6	38.2	31.9	35.6
Home health uptake per hospital, %	83.9	83.1	85.5	80.9
<b>Patient demographics</b>				
Age, y	75.5	75.3	75.4	75.1
Female, %	65.4	64.8	64.8	64.5
White, %	83.7	83.1	85.8	85.6
Black, %	6.0	5.9	6.2	5.9
Hispanic, %	6.3	6.3	4.7	4.7
AAPI, %	2.2	2.3	1.6	1.5
Elixhauser, n	2.5	2.4	2.5	2.5
Hospitalized 180 days prior, %	12.5	9.8	11.9	9.8
Home health use 180 days prior, %	10.9	8.1	10.6	8.0
Institutional PAC use 180 days prior, %	4.6	3.1	4.6	3.1
Non-metro residence, %	18.1	18.2	21.3	21.4
Residential ZIP poverty, %	13.6	12.7	13.9	13.1
Medicare-Medicaid dually eligible, %	13.5	13.1	10.8	10.1
DRG 469, %	6.2	6.5	5.9	5.9
MSAs	75	75	119	119
Hospitals	609	609	757	757
Episodes	96,601	284,495	139,870	406,008

**Source:** Authors' calculations using Medicare, American Hospital Association, and American Community Survey data.

**Notes:** All statistics are calculated at the hospital level. Pre refers to period between July 2014 and June 2015 (before CJR); Post refers to period between April 2016 and December 2018 (after CJR). SNF: Skilled Nursing Facility; MJR: Major Joint Replacement, AAPI: Asian American Pacific Islander; PAC: Post-acute Care; DRG 469: Major hip and knee joint replacement or reattachment of lower extremity with major complications and comorbid conditions or total ankle replacement; MSA: Metropolitan Statistical Area. CJR: Comprehensive Care for Joint Replacement.

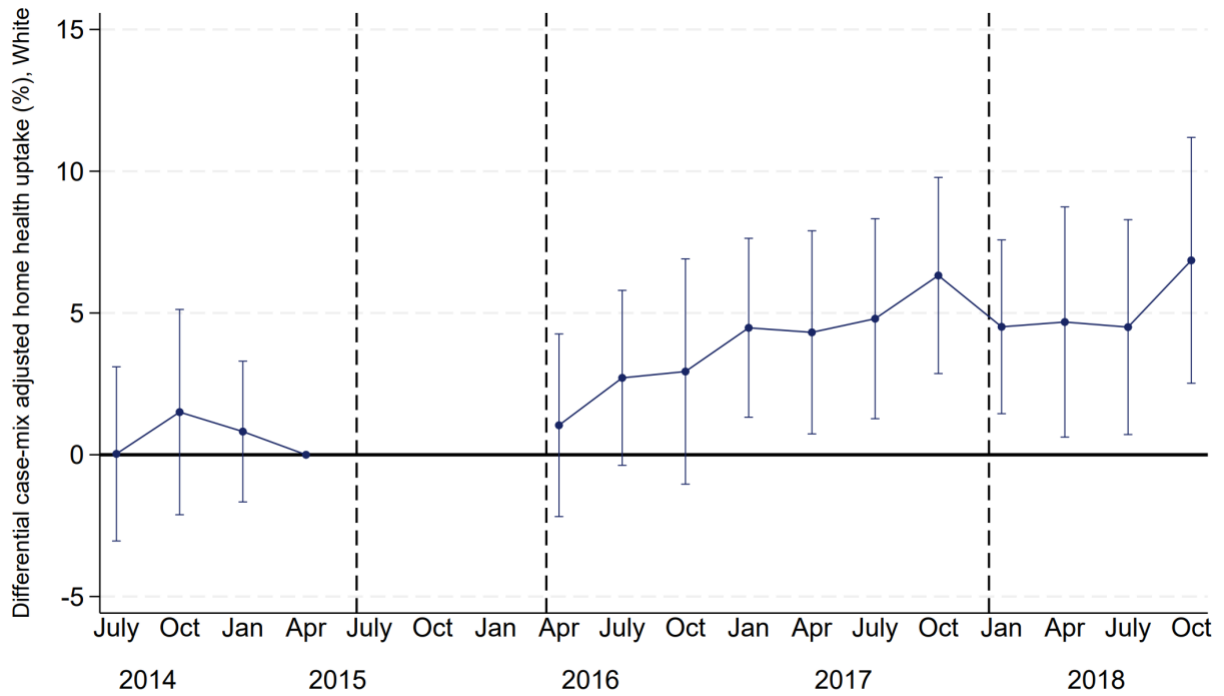
**eAppendix Figure 1.** Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the full sample



**Source:** Authors' calculations using Medicare data.

**Notes:** Pre-period (quarters beginning July 2014–April 2015): joint F-statistic = 0.670, *p*-value = 0.571.  
 Post-period (quarters beginning April 2016–October 2018): joint F-statistic = 2.564, *p*-value = 0.005.

**eAppendix Figure 2.** Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the White sample

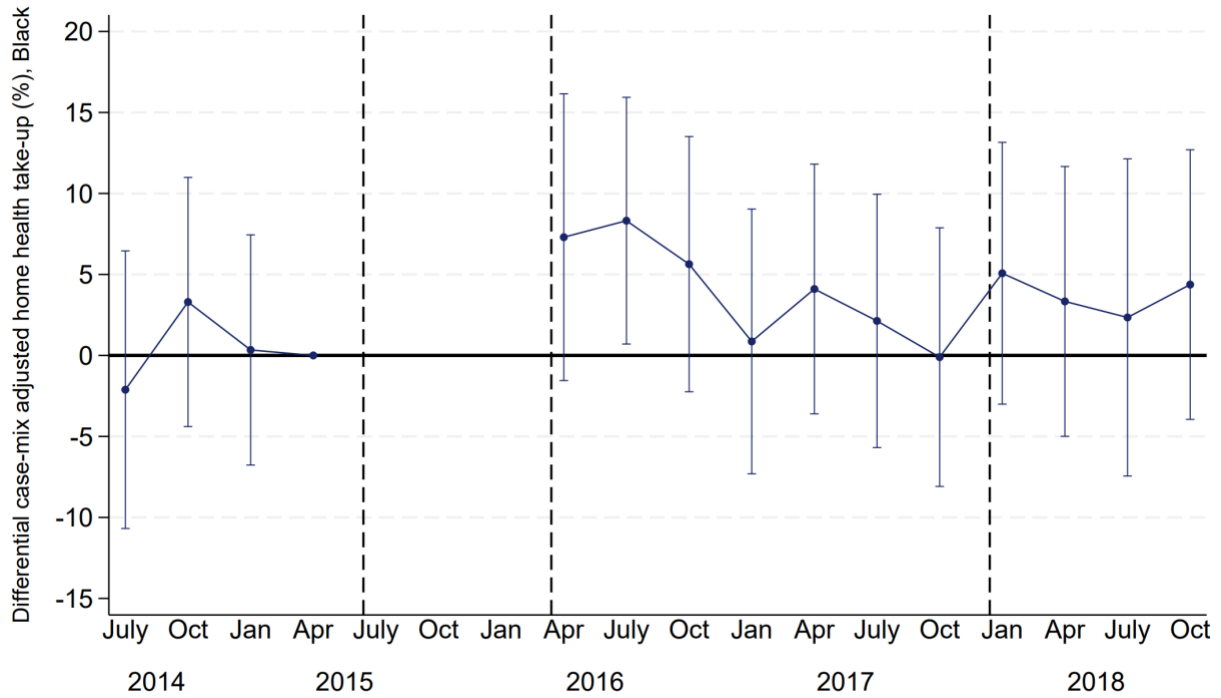


**Source:** Authors' calculations using Medicare data.

**Notes:** Pre-period (quarters beginning July 2014–April 2015): joint F-statistic = 0.420, *p*-value = 0.739.

Post-period (quarters beginning April 2016–October 2016): joint F-statistic = 2.338, *p*-value = 0.010.

**eAppendix Figure 3.** Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the Black sample

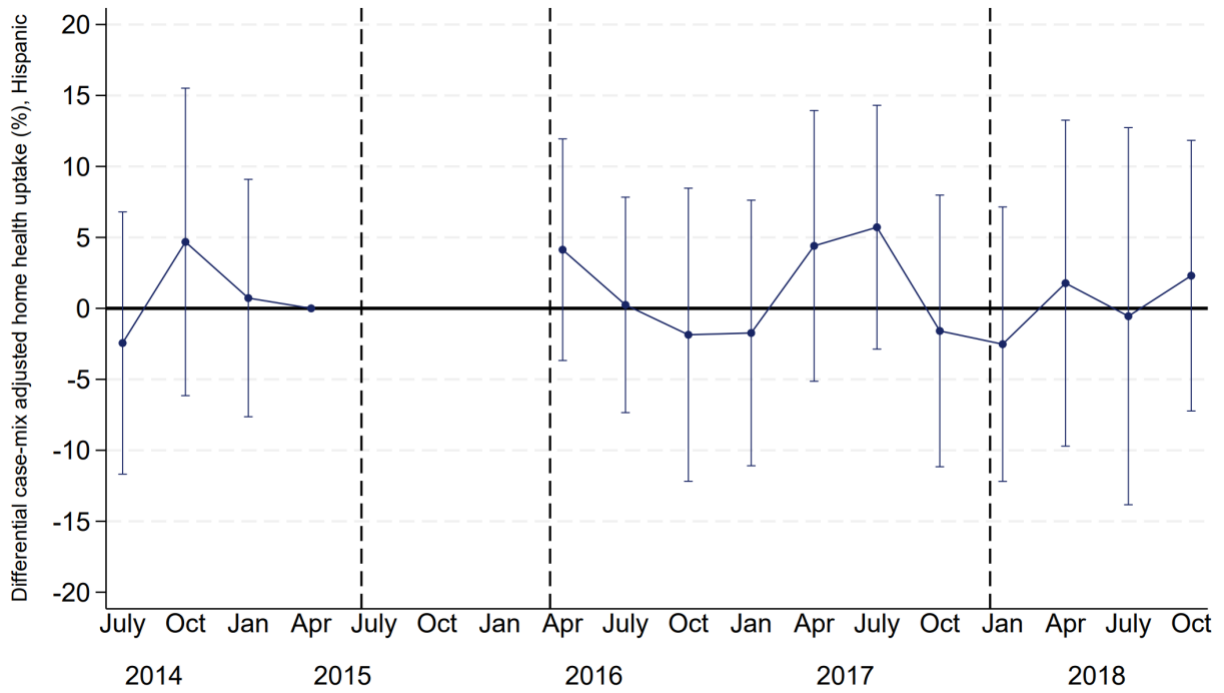


**Source:** Authors' calculations using Medicare data.

**Notes:** Pre-period (quarters beginning July 2014–April 2015): joint F-statistic = 0.545, *p*-value = 0.652.  
 Post-period (quarters beginning April 2016–October 2016): joint F-statistic = 0.951, *p*-value = 0.494.



**eAppendix Figure 4.** Quarterly differential case-mix adjusted uptake rate comparing CJR to control hospitals for the Hispanic sample

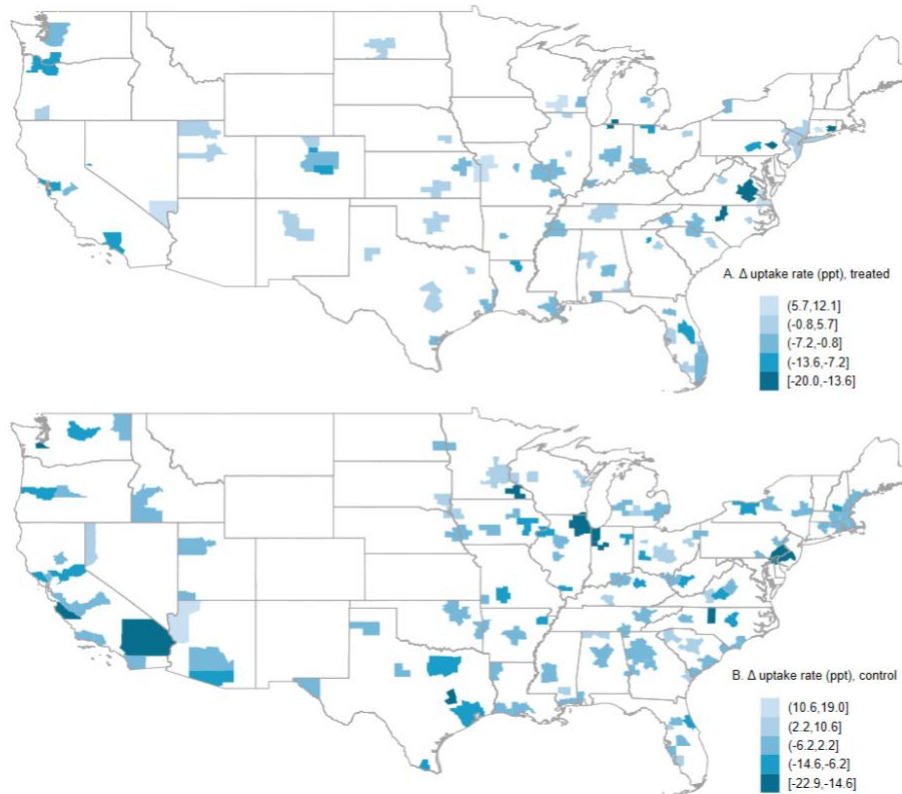


**Source:** Authors' calculations using Medicare data.

**Notes:** Pre-period (quarters beginning July 2014–April 2015): joint F-statistic = 0.453, *p*-value = 0.716. Post-period (quarters beginning April 2016–October 2016): joint F-statistic = 0.833, *p*-value = 0.607.



**eAppendix Figure 6.** Changes in uptake rates of prescribed home health care by treatment and control groups in the Comprehensive Care for Joint Replacement program.



**Source:** Authors' calculations using Medicare data.

**Notes:** Changes in uptake rates are calculated by taking post-Comprehensive Care for Joint Replacement (CJR) rates minus Pre-CJR rates, where post-CJR refers to July 2014 through June 2015 and pre-CJR refers to April 2016 through December 2018. Metropolitan statistical areas (MSAs) randomly selected for treatment and control in CJR are displayed in Panel A and B, respectively.