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RESEARCH ARTICLE

Effect of Hospital and Post-Acute Care Provider Participation in Accountable Care Organizations on Patient Outcomes and Medicare Spending

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Objective. To test for differences in patient outcomes when hospital and post-acute care (PAC) providers participate in accountable care organizations (ACOs).

Data/Setting. Using Medicare claims, we examined changes in readmission, Medicare spending, and length of stay among patients admitted to ACO-participating hospitals and PAC providers.

Design. We compared changes in outcomes among patients discharged from ACO-participating hospitals/PACs before and after participation to changes among patients discharged from non-participating hospitals/PACs over the same time period.

Results. Patients discharged from an ACO-participating hospitals and skilled nursing facilities (SNF) had lower readmission rates (−1.7 percentage points, *p*-value = .03) than before ACO participation and non-participants; and lower per-discharge Medicare spending (−$940, *p*-value = .001), and length of stay (−3.1 days, *p*-value <.001) in SNF. Effects among ACO-participating hospitals without a co-participating SNF were smaller. Patients discharged from an ACO-participating hospital and home health agency had lower Medicare per-discharge spending (−$209; *p*-value = .06) and length of stay (−1.6 days, *p*-value <.001) for home health compared to before ACO participation and non-participants. Discharge from an ACO-participating hospital and inpatient rehabilitation facility did not impact patient outcomes or spending.

Conclusions. Hospital and SNF participation in an ACO was associated with lower readmission rates, Medicare spending on SNF, and SNF length of stay. These results lend support to the ACO payment model.

Key Words. Post-acute care, hospitals, accountable care organizations, Medicare

By creating incentives to manage the health of their members across health care settings, accountable care organizations (ACOs) have the potential to induce providers to work together to improve coordination of care and, thus, reduce unnecessary health care utilization, improve patient outcomes, and

reduce health care spending (McClellan et al. 2010; Berwick 2011). One of Medicare's largest experiments the ACO model is the Medicare Shared Savings Program (MSSP). Prior work has shown this ACO model was associated with reductions in overall Medicare payments and stable-to-improved quality for beneficiaries attributed to its ACOs (McWilliams et al. 2015, 2016).

The transition between hospitals and post-acute care (PAC) providers may be a particularly important point for ACOs to improve care. PAC use is common, costly, and highly variable in Medicare (Chandra, Dalton, and Holmes 2013; Institute of Medicine 2013; MedPAC 2017). Thus, ACOs may give providers incentives to more effectively manage the post-discharge transition and thus improve patient outcomes and reduce Medicare costs. Indeed, early evidence suggests that ACOs decreased institutional PAC utilization, including skilled nursing facilities (SNFs) and inpatient rehabilitation facilities (IRFs), and reduced spending on SNFs for Medicare beneficiaries attributed to an ACO (McWilliams et al. 2016, 2017).

Prior studies have focused on the effects of ACOs among ACO-attributed beneficiaries (Nyweide et al. 2015; McWilliams et al. 2016, 2017). However, only a fraction of the 57.5 million Medicare beneficiaries nationwide are attributed to an ACO (Fuchs 1996; Centers for Medicare and Medicaid Services 2017). Furthermore, the effects of ACOs might not be limited to those attributed beneficiaries. Particularly, in the case of hospital-to-PAC transitions, ACO participation might encourage hospitals and PAC providers to make changes to their discharge transition processes that will affect all patients—attributed and non-attributed alike.

Our objective, therefore, was to test the effect of hospital and PAC participation in ACOs on patient outcomes and health care spending across all hospitalized patients, not just those attributed to an ACO. We first describe the extent of PAC participation in Medicare's MSSP ACO program. Then, using Medicare claims, we examine changes in readmission rates, Medicare spending, and length of stay for beneficiaries admitted to hospitals

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participating in ACOs with and without co-participating PAC providers compared to non-participating hospitals.

METHODS

Conceptual Framework

Conceptually, hospital and PAC participation in ACOs has the potential to reduce readmission rates in several ways. High readmission rates may be partially attributed to poor coordination of care at hospital discharge, with patients often experiencing medication errors, receiving incomplete or inaccurate information, and lacking appropriate follow-up care (Beers, Sliwkowski, and Brooks 1992; van Walraven et al. 2002; Moore et al. 2003; Coleman et al. 2005). Hospitals participating in ACOs may focus on improving patients' transitions between the hospital and PAC settings through mechanisms such as shared electronic health records, sharing physicians or nurses across settings to promote continuity, or preferentially sharing patients between hospitals and PAC providers creating high-volume relationships that foster smoother transitions. These changes in care delivery could impact the care of all patients, not just patients attributed to ACOs. Furthermore, if hospitals and PAC providers work together to coordinate care across settings—for example, by participating together in an ACO—they might have an even larger effect on the hospital discharge transition.

Hospital and PAC provider participation in ACOs might affect more than just readmission rates. With its focus on value, ACO participation has the potential to reduce Medicare spending during a hospital episode of care, most likely by reducing post-hospitalization costs (because hospital payment is determined prospectively). Reduced spending might happen in part through reduced readmission rates, but also through more efficient use of PAC—by reducing the length or intensity of PAC use. While this could reduce revenue for PAC providers, developing preferential relationships with hospitals with a steady referral stream, and participating in shared savings might offset any reduction in revenue.

We thus hypothesize that hospital and PAC participation in ACOs will improve outcomes and reduce costs across all patients. Further, this effect will be larger in hospitals and PACs that participate jointly in an ACO compared to hospitals that participate in an ACO without a PAC provider.

Study Population

Our study cohort started with the universe of acute care hospitals and Medicare-certified PAC providers between 2010 and 2013: 3,506 hospitals, 15,291 SNFs, 11,213 HH agencies, and 1,198 IRFs. Then, within each hospital, we created three cohorts of Medicare fee-for-service (FFS) beneficiaries: those discharged to SNF, HH, or IRF within 2 days of hospital discharge.

We excluded beneficiaries enrolled in Medicare Advantage in the 1 year prior to hospital discharge (the period during which we measure patient comorbidities) or the 60 days after hospital discharge (the period during which we measure patient outcomes) to insure claims are completely identified; we excluded beneficiaries not eligible for Medicare's hospital readmission measure, one of our main outcomes. This excluded beneficiaries discharged from the hospital against medical advice, admitted to a PPS-exempt cancer hospital, or with hospital admissions for cancer treatment, primary psychiatric disease, rehabilitation care, or fitting of prostheses and adjustment devices.

We included all beneficiaries regardless of whether they are attributed to an ACO, examining the effect of hospital and PAC participation in ACOs on Medicare beneficiaries on average, not just those attributed to an ACO. We thus focus on whether there are spillovers to non-attributed patients when a hospital participates in an ACO.

Data

Provider-level data were obtained from two sources. First, to determine hospital and PAC provider participation in the MSSP, we obtained publicly available lists from the Centers for Medicare and Medicaid Services (CMS) of participants in the 222 ACOs that joined the MSSP from April 2012 through January 2013. We then categorized whether or not each ACO participant was a hospital, SNF, HH agency, or IRF. For each PAC provider, we noted whether it participated in an ACO that also included a hospital participant (and which hospital was part of the ACO). In cases where it was unclear how to categorize the ACO participant (e.g., if a hospital was included as a participant, and that hospital had an IRF located within it but the IRF was not listed separately as a participant), we contacted the ACO directly by phone and email to clarify participation. We also categorized each ACO participant by the date the ACO joined the MSSP. Second, for descriptive purposes, we obtained hospital characteristics from Medicare's 2013 Provider of Service File.

We obtained hospital discharge-level data using Medicare claims to observe all hospitalizations and PAC use in our cohort between 2010 and 2013 (from the 100 percent MedPAR file and home health claims). These claims data were supplemented with the Medicare Beneficiary Summary File, containing information on beneficiary enrollment and demographics.

Outcome Variables

We measured the impact of ACO participation on three primary patient-level outcomes: hospital readmission or death, Medicare spending, and length of stay. We measured hospital readmission within 30 days of hospital discharge following Medicare's definition for hospital-wide all-cause readmission, which includes unplanned readmissions to any acute care hospital within 30 days of discharge from a hospital. We then created a combined endpoint of readmission or death within 30 days of hospital discharge to account for censoring by death. If participating in an ACO makes hospitals and PAC providers more effective at coordinating care across the post-discharge transition, we expected to see a decline in readmission rates for hospitals and PACs that are ACO participants. We additionally examined death within 30 days of discharge separately.

Our second primary outcome measure was Medicare spending, which was measured over an episode of care encompassing both the hospitalization and PAC stay. We defined the episode as 60 days from the date of hospital admission. We chose 60 days because 90 percent of hospital-PAC episodes in our data are less than 60 days and thus are encompassed within the 60-day episode. We included Medicare spending on the index hospitalization, the index PAC stay, and any rehospitalizations and/or subsequent PAC use during the first 60 days following the index hospitalization date. If participating in an ACO makes hospitals and PAC providers more effective at managing the post-discharge transition, we expected to see a decline in total Medicare spending. As secondary outcomes, we also examined separately spending made in the first 60 days for the index hospitalization and index PAC use. We tested for differences in Medicare spending on the initial hospitalization, but because Medicare determines payment for hospitalizations prospectively based on the hospitalizations' Diagnosis Related Group (DRG), we did not anticipate differences in Medicare spending with ACO participation. PAC is also paid prospectively, but the details of the payment systems vary by setting. SNF payments are a per diem rate set prospectively based on expected service intensity during the stay. HH and IRF payments are most often episode-based

payments adjusted for illness severity and set for a 60-day episode regardless of number of expected visits. However, HH and IRF payments are adjusted downward for short episodes of care. Thus, we expected to see decreases in PAC payments with ACO participation.

Our third primary outcome was length of stay. Like our spending outcome, we measured length of stay for the entire 60-day period following hospital admission, which includes both the index hospital and PAC stay. We test the effect of ACO participation on length of stay to help examine the mechanism of any changes in Medicare spending that we might observe. We thus expected to see declines in length of stay over the episode with ACO participation, particularly among PAC providers. We also examine the secondary outcomes of hospital length of stay and PAC length of stay separately.

Main Independent Variable

Our main independent variables were dummy variables indicating whether each beneficiary went to a hospital/PAC provider that was participating in an ACO. We created two versions of this variable. First, to assess whether participation in ACOs by hospitals alone is effective at improving transitions of care, we created a dummy variable that equaled one for patients admitted to a hospital that joined an ACO after it joined the ACO, zero before, and zero if the hospital never joined an ACO during our study period. Second, to assess the effect of hospital *and* PAC participation in the same ACO, we created a dummy variable that equaled one for patients admitted to a hospital and a PAC that joined the same ACO after they join the ACO, zero before, and zero if the hospital and/or PAC never joined an ACO during our study period.

Covariates

In all regressions, we controlled for patient sociodemographics (age, sex, race, and dual enrollment in Medicare and Medicaid), 31 comorbidities defined by Medicare for their readmission measure (see Table S1 for a full list), DRG fixed effects (i.e., a dummy variable for each DRG), hospital fixed effects, and a fixed effect for each 6-month period during our study. Hospital fixed effects controlled for all unobservable, time-invariant hospital characteristics that might be related to both ACO participation and our outcomes of interest. Time fixed effects controlled for national secular trends in our outcomes of interest. While we do not directly include controls for market, the inclusion of hospital fixed effects controls for differences across markets, as hospitals are

nested within markets. Similarly, because ACO participation is defined at the hospital-level, ACO fixed effects would be redundant with hospital fixed effects.

Analytic Approach

We used difference-in-differences analyses to examine the effect of hospital/PAC participation in ACOs on patient outcomes and spending. This approach compares changes in outcomes among patients receiving care at a hospital/PAC participating in an ACO before and after ACO participation began to changes in outcomes among patients receiving care at a hospital/PAC not participating in an ACO over the same time period.

For a difference-in-differences approach to be valid, two important assumptions must hold. First, the difference-in-differences approach assumes there are no underlying changes or differences in the patient population that are correlated with both ACO implementation and patient outcomes. To test the validity of this assumption, we examined the balance of changes in observed patient covariates from the beginning to the end of our study period across patients going to hospitals joining ACOs and those going to hospitals not joining ACOs. Evidence of covariate balance in trends helps insure that the types of patients admitted to ACO and non-ACO hospitals did not change significantly over the study period and, thus, any observed changes in the outcomes of interest are due to ACO participation rather than differential changes in patient characteristics between groups over time. To test this, we used linear regressions to regress each covariate on an indicator for whether the hospital ever participated in an ACO, an indicator for the year the covariate was observed (2010 vs. 2013), and the interaction between the two. The coefficient on the interaction measures differences in the change in covariate from 2010 to 2013 between patients at hospitals that participated in an ACO versus not. We also tested for balance in covariate trends across patients going to hospitals and PAC providers that participated in ACOs compared to patients going to hospitals and PAC providers that did not participate in ACOs using the same methods.

Second, the differences-in-differences approach assumes that trends in patient outcomes would have been the same between ACO participants and non-participants had ACOs not been implemented. While the counterfactual of no ACO implementation cannot be directly tested, we can test whether trends in patient outcomes were different in the pre-ACO-implementation period. If we find no differences, or if only small differences are found, it

strengthens the validity of the assumption that they would have been the same in the post-implementation period had ACOs not been implemented and thus any observed changes can be attributed to the ACO. To test this assumption, we limited our observations to the period before the MSSP began—2010 to 2011—and regressed each primary outcome of interest on a linear time trend over that period, an indicator for whether the hospital joined an ACO during our study period, and the interaction between the two. This was performed both comparing hospitals that ever joined an ACO to hospitals that never joined an ACO and also comparing hospitals that ever joined an ACO *with a PAC provider* to hospitals that never joined an ACO *with a PAC provider*. The coefficient on the interaction measures the difference in outcome trends between the ACO and non-ACO group over the pre-implementation period. Furthermore, a typical difference-in-differences analysis that examines changes in an outcome after a single implementation date. The implementation of the MSSP, however, was staggered over three different ACO start dates during the study period. This is a stronger difference-in-differences approach than is typical and makes the non-differential trends assumption weaker.

To estimate the effect of hospital/PAC participation in ACOs on patient outcomes, we conducted difference-in-differences analyses using linear regression with the following longitudinal fixed-effect model:

$$Y_{i,j,t} = \beta_1 * \mathrm{ACO}_{j,t} + \theta * X_{i,t} + \gamma_j + \varphi_t + \varepsilon_{i,j,t}$$

where i indexes patients, j indexes hospitals, and t indexes the half-year. Our outcome, $Y_{i,j,t}$, measures the outcomes specified above (readmission, death, Medicare spending, and length of stay). Our main independent variable, $\mathrm{ACO}_{j,t}$, is a time-varying measures of whether a hospital (or hospital-PAC pair) participates in an ACO which equals one after a hospital starts participating, zero before, and zero if the hospital never participates in an ACO during our study period. We also include a vector of patient covariates, hospital fixed effects, and time fixed effects.

Our coefficient of interest is β_1, which, in combination with the time and hospital fixed effects, provides a difference-in-differences estimator, or the effect of admission to an ACO-participating hospital on patient outcomes compared to admission to that hospital before it participated in an ACO and compared to admission to non-ACO-participating hospitals over the same time period. By including hospital fixed effects, we directly compared patients admitted to the same hospital before versus after ACO participation, and allow each hospital to serve as a control for itself, thus, controlling for

unobserved heterogeneity across hospitals that often biases the results of observational studies. By including non-participating hospitals, we control for secular trends in our outcomes. We then re-estimated this model using a measure of whether both the hospital and PAC provider participated in an ACO. For both ACO indicators, models were estimated separately for each PAC cohort (SNF, HH, and IRF) and for each outcome variable. To control for censoring by death, we included death in the readmission outcome (measuring death or readmission with 30 days of admission). For regressions, using spending or length of stay as a dependent variable included a dummy variable indicating whether the patient died in the first 60 days and the number of days censored due to death. We used robust variance estimators to adjust standard errors for clustering of observations within hospital.

After estimating the effect of ACO participation on our outcomes of interest, we re-estimate the above specified regression including PAC provider characteristics. If ACOs are strategically forming partnerships with PAC providers who are better positioned to provide high-quality and high-value care, we would expect that the inclusion of PAC provider characteristics would diminish any documented effect although might remain significant if ACO participation had independent effects on the outcomes of interest. We included as covariates total number of beds (for SNF and IRF), total full-time equivalent of staff (for HH), whether the provider was hospital owned, profit status, and overall 5-star quality measure from Medicare's Nursing Home Compare (for SNFs only).

To test the robustness of our results, we re-estimated the effects of ACO participation after creating a propensity-score matched set of hospitals. We matched ACO-participating hospitals to non-participating hospitals using nearest neighbor matching without replacement, matching one ACO-participating hospital to five non-participating hospitals based on number of beds, profit status, rural location, and teaching status. We chose 1 : 5 matching because it maintained excellent balance on observable characteristics across cohorts while maximizing the number of hospitals included in the matched cohort. Once the matched cohort was created, we re-estimated the difference-in-difference model specified above for all outcomes of interest.

RESULTS

In the 222 ACOs participating in the MSSP by January 2013, 89 ACOs (40.1 percent) included an acute care hospital and 60 (27.0 percent) included one or

more PAC providers (Table 1). IRFs were the most common type of PAC included in an ACO, followed by HH agencies and SNFs. In total, 207 PAC providers participated in 222 ACOs: 49 SNFs, 55 HH agencies, and 103 IRFs. PAC participation was almost exclusively in ACOs with a hospital participant (54 of the 60 ACOs that included PACs also included a hospital). Of the 89 ACOs with hospital participation, 60.7 percent had a PAC participant of any type, 16.9 percent had a SNF participant, 25.8 percent had a HH agency participant, and 55.1 percent had an IRF participant.

The characteristics of hospitals participating in an ACO with a PAC participant differed from those without a PAC participant and also differed from hospitals not participating in an ACO (Table 2). Hospitals participating in an ACO with a PAC provider tended to be larger, were less likely to be for-profit, rural, and non-teaching hospitals compared to hospitals participating in an ACO without a PAC provider and compared to hospitals not participating in an ACO.

A total of 3,503,296 patients in our study were discharged to SNF (13.1 percent of whom when to a hospital that ever participated in an ACO), 1,597,751 to HH (12.3 percent from an ACO hospital), and 445,264 to IRF (11.6 percent from an ACO hospital) are summarized in Table 3. The SNF cohort was older, more likely to be female and black, and had higher levels of most comorbidities compared to the HH and IRF cohorts. They were also more likely to be hospitalized for sepsis, UTI, or pneumonia than the other two cohorts, but less likely to be hospitalized for total hip or knee replacement.

When examining changes in patient characteristics over time, we found that while patient characteristics changed between 2010 and 2013, they did not change differentially between ACO participants and non-participants. The types of patients admitted to ACO-participating versus non-ACO-participating hospitals were very similar over time and, when there were statistically

Table 1: Description of ACOs Included in Study

	Among All ACOs	*Among ACOs with a Hospital*
Total number of ACOs	222	89
ACOs with a hospital, *n* (%)	89 (40.1)	
ACOs with one or more PAC provider, *n* (%)	60 (27.0)	54 (60.7)
ACOs with one or more SNF, *n* (%)	16 (7.2)	15 (16.9)
ACOs with one or more HH agency, *n* (%)	29 (13.1)	23 (25.8)
ACOs with one or more IRF, *n* (%)	49 (22.1)	49 (55.1)

Table 2: Characteristics of Hospitals in ACOs with PAC Providers, in ACOs without PAC Providers, and Not in ACOs

	Hospitals Participating in ACO with PAC	*Hospitals Participating in ACO without PAC*	*Hospitals Not Participating in an ACO*
Number of hospitals, *n* (%)	182 (5.2%)	111 (3.2%)	3,213 (91.6%)
Number of SNFs	49		
Number of HH agencies	55		
Number of IRFs	103		
Number of beds, *n* (%)			
<100	19 (12.6%)	33 (29.7%)	1,140 (35.5%)
100–250	56 (30.8%)	43 (38.7%)	1,088 (33.9%)
250+	107 (58.8%)	35 (31.5%)	985 (30.7%)
Profit status, *n* (%)			
For profit	10 (5.5%)	13 (11.7%)	772 (24.0%)
Not for profit	152 (83.5%)	88 (79.3%)	1,851 (57.6%)
Public	20 (11.0%)	10 (9.0%)	590 (18.4%)
Rural, *n* (%)	23 (12.6%)	18 (16.2%)	942 (29.3%)
Teaching status, *n* (%)			
Non-teaching	95 (52.2%)	74 (66.7%)	2,233 (69.5%)
Minor teaching	47 (25.8%)	22 (19.8%)	585 (18.2%)
Major teaching	40 (22.0%)	15 (13.5%)	395 (12.3%)

significant differences, they were small (Table 3). Similarly, the types of patients admitted to ACO-participating versus non-ACO-participating hospitals and PAC providers were also very similar over time (Table S2).

Patient outcomes are summarized in Table 4. Patients discharged to SNF had higher readmission and mortality rates compared to those discharged to HH or IRF. Medicare per-discharge spending on patients discharged to IRF was significantly higher for hospitalization (consistent with higher rates of surgical DRGs) and for PAC than those discharged to SNF or HH. The trends in outcomes were not statistically different from each other prior to 2012 in hospitals that did and did not join an ACO, and also in hospitals that did and did not join an ACO with a PAC provider. For both groups and for all outcomes, the differences in trends in outcomes prior to ACO implementation between ACO participants and non-participants were very small and were statistically indistinguishable from zero (Table S3).

In multivariable regression among patients discharged from a hospital to a SNF, being in an ACO-participating hospital, was associated with a 0.5 percentage points lower relative rate of readmission or death compared to

Table 3: For Patients Discharged to Each PAC Setting, Characteristics of Patients at Hospitals that Joined and Did Not Join an ACO before and after Hospitals Joined ACOs

	Skilled Nursing Facility Cohort (n = 3,503,296)				*Home Health Cohort (n = 1,597,751)*				*Inpatient Rehabilitation Cohort (n = 445,264)*			
	Mean	*Change in ACO Hospitals**	*Change in Non-ACO Hospitals†*	*p-Value‡*	*Mean*	*Change in ACO Hospitals**	*Change in Non-ACO Hospitals†*	*p-Value‡*	*Mean*	*Change in ACO Hospitals**	*Change in Non-ACO Hospitals†*	*p-Value‡*
Age in years, mean	82.1	0.1	0.1	.27	78.7	−0.1	−0.1	.68	79.2	0.1	0.1	.92
Female, %	64.3	−0.7	−0.9	.46	59.3	−0.5	−0.8	.45	59.3	−1.3	−1.5	.75
Race, %												
White	86.7	−0.5	−0.5	.83	86.1	0.1	−0.3	.22	87.2	−1.2	−0.4	.14
Black	9.3	0.2	0.1	.86	8.8	−0.1	0.0	.53	8.4	0.5	0.3	.75
Hispanic	1.5	0.0	0.0	.91	1.9	−0.2	−0.1	.64	1.6	0.0	−0.1	.42
Other	2.3	0.3	0.3	.49	2.9	0.1	0.2	.16	2.6	0.4	0.0	.04
Dual eligible, %	26.4	−1.7	−1.9	.44	13.4	−1.1	−0.7	.34	9.9	−0.5	−0.4	.95
Comorbidities, %												
Diabetes	34.7	6.1	6.3	.36	32.5	3.5	4.6	.003	33.7	6.4	7.3	.16
Cancer	11.5	1.5	1.7	.25	12.1	0.9	0.9	.92	9.6	1.5	1.6	.74
Acute kidney disease	25.7	3.0	3.5	.07	16.6	1.6	2.2	.03	16.3	3.5	3.9	.55
Congestive heart failure	24.9	0.7	1.0	.25	17.5	−0.3	0.0	.30	15.8	1.9	2.2	.63
Ischemic heart disease	58.1	9.2	9.2	.91	50.9	4.7	5.5	.11	51.5	9.3	10.0	.37

continued

Table 3. *Continued*

	Skilled Nursing Facility Cohort (n = 3,503,296)				*Home Health Cohort (n = 1,597,751)*				*Inpatient Rehabilitation Cohort (n = 445,264)*			
	Mean	*Change in ACO Hospitals**	*Change in Non-ACO Hospitals†*	*p-Value‡*	*Mean*	*Change in ACO Hospitals**	*Change in Non-ACO Hospitals†*	*p-Value‡*	*Mean*	*Change in ACO Hospitals**	*Change in Non-ACO Hospitals†*	*p-Value‡*
Chronic obstructive pulmonary disease	28.2	3.9	4.2	.40	25.0	2.2	2.9	.08	22.0	5.4	4.6	.28
Reason for hospitalization, %												
Total hip or knee replacement	8.4	0.1	0.2	.64	13.2	1.5	1.1	.42	13.9	−2.0	−2.6	.45
Sepsis	6.3	1.8	1.8	.98	3.4	1.2	1.3	.32	2.1	0.7	1.0	.11
Congestive heart failure	5.2	0.0	0.0	.66	6.3	−0.2	0.0	.24	2.3	0.5	0.5	.96
Urinary tract infection	4.4	−0.3	−0.4	.34	2.5	−0.1	0.0	.90	1.3	0.2	0.2	.94
Hip fracture	5.6	0.1	−0.1	.08	0.9	0.0	−0.1	.16	9.8	−0.7	−1.3	.24
Pneumonia	4.4	0.3	0.3	.96	4.1	0.5	0.5	.75	1.5	0.1	0.5	.04

*Change from 2010 to 2013 among patients admitted to a hospital that participated in an ACO during the study period.
†Change from 2010 to 2013 among patients admitted to a hospital that did not participate in an ACO during the study period.
‡*p*-Value for difference in change over time between ACO hospitals and non-ACO hospitals.

Table 4: Summary of Outcomes among Patients Discharged from the Hospital to SNF, to HH, and to IRF in 2010–2011

	SNF Cohort	*HH Cohort*	*IRF Cohort*
30-day readmission or mortality, %	31.6	18.7	21.2
30-day mortality, %	13.9	4.2	4.9
Medicare spending on total episode in $, mean	23,968	17,038	36,638
Medicare spending on index hospitalization in $, mean	11,173	11,460	15,000
Medicare spending on index PAC stay in $, mean	7,359	2,522	14,560
Length of stay for total episode in days, mean	31.1	37.6	19.8
Length of hospital stay in days, mean	7.2	6.1	7.1
Length of PAC stay in days, mean	23.8	31.5	12.7

before ACO implementation and compared to being in a non-ACO-participating hospital over the same time period (p-value .008; see Table 5). This effect was larger for patients who went to a hospital and SNF that both participated in the same ACO, with a 1.6 percentage point relative lower combined endpoint of readmission and mortality compared to before ACO implementation and compared to being in a non-ACO-participating hospital or SNF (p-value .03). There was no significant effect of ACO participation on 30-day mortality alone regardless of whether a SNF also participated in the ACO. Discharge from an ACO-participating hospital was associated with lower relative per-discharge Medicare spending of $184 ($p$-value .007) compared to before ACO implementation and compared to being discharged from a non-ACO-participating hospital, but there was no statistically significant difference in length of stay. However, discharge from an ACO-participating hospital to a SNF participating in the same ACO was associated with significantly lower relative per-discharge Medicare spending on the hospital-SNF episode (by $1,601, p-value <.001) compared to before and compared to discharges from non-ACO-participating hospitals and SNFs, which was concentrated in SNF payments (by $888, p-value .002); and a lower relative hospital-SNF episode length of stay (by 2.8 days, p-value <.001), which was also concentrated in SNF length of stay (by 2.9 days, p-value <.001) compared to before ACO implementation and compared to being in a non-ACO-participating hospital or SNF.

Patients discharged from an ACO-participating hospital to HH experienced a modestly lower relative rate of readmission and mortality (0.4 percentage points, p-value .03) but not mortality alone (0.1 percentage points, p-value .33) compared to before ACO participation and compared to discharge from a non-ACO-participating hospital, while discharge from an ACO-

Table 5: Adjusted Change in Outcomes after a Hospital or Post-Acute Care Provider Joined an ACO

	Skilled Nursing Facility Cohort (n = 3,503,296)			
	Hospital in ACO		*Hospital and Skilled Nursing Facility in ACO*	
	Absolute Change [95% CI]	*p-Value*	*Absolute Change [95% CI]*	*p-Value*
30-day readmission or mortality (%)	−0.5 [−0.9 to −0.1]	.008	−1.7 [−3.2 to −0.2]	.03
30-day mortality (%)	−0.1 [−0.4 to 0.2]	.53	−0.6 [−1.9 to 0.7]	.34
Medicare spending on total episode ($)	−184 [−317 to −51]	.007	−1,614 [−2,380 to −848]	<.001
Medicare spending on hospitalization ($)	−59 [−140 to 22]	.16	−161 [−358 to 35]	.11
Medicare spending on PAC ($)	23 [−56 to 101]	.57	−940 [−1,517 to −363]	.001
Length of stay in total episode (days)	−0.0 [−0.2 to 0.2]	.86	−3.1 [−4.3 to −2.0]	<.001
Length of stay in hospital (days)	0.0 [−0.0 to 0.1]	.78	0.1 [−0.1 to 0.4]	.35
Length of stay in PAC (days)	0.1 [−0.1 to 0.2]	.20	−2.8 [−4.1 to −1.6]	<.001
	Home Health Cohort (n = 1,597,751)			
	Hospital in ACO		*Hospital and Home Health Agency in ACO*	
	Absolute Change [95% CI]	*p-Value*	*Absolute Change [95% CI]*	*p-Value*
30-day readmission or mortality (%)	−0.4 [−0.8 to −0.03]	.03	−0.4 [−1.1 to 0.3]	.23
30-day mortality (%)	−0.1 [−0.3 to 0.1]	.32	−0.1 [−0.5 to 0.3]	.66
Medicare spending on total episode ($)	−56 [−178 to 65]	.36	−209 [−431 to 12]	.06
Medicare spending on hospitalization ($)	−45 [−144 to 53]	.37	−89 [−294 to 116]	.40
Medicare spending on PAC ($)	46 [19 to 73]	.001	−38 [−75 to 0]	.05
Length of stay for total episode (days)	−0.1 [−0.5 to 0.2]	.42	−1.6 [−2.3 to −0.9]	<.001

continued

Table 5. *Continued*

	Home Health Cohort (n = 1,597,751)			
	Hospital in ACO		*Hospital and Home Health Agency in ACO*	
	Absolute Change [95% CI]	*p-Value*	*Absolute Change [95% CI]*	*p-Value*
Length of stay in hospital (days)	0.0 [−0.1 to 0.0]	.32	0.0 [−0.1 to 0.1]	.85
Length of stay in PAC (days)	−0.1 [−0.4 to 0.2]	.52	−1.6 [−2.2 to −1.1]	<.001
	Inpatient Rehabilitation Cohort (n = 445,264)			
	Hospital in ACO		*Hospital and Inpatient Rehabilitation Facility in ACO*	
	Absolute Change [95% CI]	*p-Value*	*Absolute Change [95% CI]*	*p-Value*
30-day readmission or mortality (%)	−0.4 [−1.3 to 0.4]	.32	0.4 [−0.9 to 1.6]	.57
30-day mortality (%)	−0.5 [−1.0 to 0.0]	.05	0.1 [−0.6 to 0.8]	.74
Medicare spending on total episode ($)	189 [−212 to 591]	.36	−62 [−604 to 480]	.83
Medicare spending on hospitalization ($)	52 [−196 to 301]	.68	−133 [−363 to 97]	.26
Medicare spending on PAC ($)	28 [−199 to 255]	.81	−85 [−470 to 300]	.67
Length of stay in total episode (days)	0.2 [−0.3 to 0.6]	.41	0.5 [−0.1 to 1.2]	.09
Length of stay in hospital (days)	−0.1 [−0.2 to 0.0]	.12	−0.1 [−0.3 to 0.0]	.15
Length of stay in PAC (days)	0.1 [−0.1 to 0.3]	.26	0.1 [−0.2 to 0.4]	.37

participating hospital to a HH agency participating in the same ACO resulted in no significant difference in readmission or morality rates. However, there was slightly lower relative per-discharge Medicare spending on HH ($38, *p*-value .05), total episode days of service (1.6 days, *p*-value <.001), and HH days of service (of 1.7 days, *p*-value <.001) compared to before ACO implementation and compared to being in a non-ACO-participating hospital and HH agency.

Patients discharged from the hospital to inpatient rehabilitation experienced similar outcomes regardless of whether the hospital or the IRF participated in an ACO except a modest and marginally significantly lower mortality among patients discharged from ACO-participating hospitals.

After controlling for PAC characteristics, the estimated effect of hospital participation in an ACO remained unchanged. However, the effect of hospital and SNF participation in the same ACO decreased in magnitude (Table S4). The effect of hospital and SNF participation on 30-day readmission or mortality became non-statistically significant. The effect of hospitals and SNFs participation in the same SNF was associated with significantly lower Medicare spending and length of stay. The effects in the HH and IRF cohort remained qualitatively similar. After creating a propensity-score-matched cohort of hospitals, ACO-participating and non-participating hospitals were well balanced on observable characteristics (Table S5). The results of the multivariate regressions in this cohort remained largely unchanged (see Table S6).

Discussion

We find that when hospitals and SNFs participated together in the same MSSP ACO, patients experienced significantly lower relative readmission and death rates, per-discharge Medicare spending on SNF, and SNF length of stay compared to before ACO participation and compared to patients discharged from non-ACO-participating hospitals and SNFs. These effects are partially driven by the types of SNFs that are included in ACOs, but independent of these characteristics hospitals and SNFs that participate together in the same ACO have lower per-discharge Medicare spending and shorter length of stay. On the other hand, when hospitals participated in an ACO without a SNF, the readmission and death rates were only slightly lower relative to before ACO participation and to non-participating hospitals, and there was no difference in per-discharge Medicare spending or length of stay. The effect of having hospitals and HH agencies participating in the same ACO was more modest, although led to a relative reduction in per-discharge Medicare spending on HH. A hospital participating in an ACO without a HH agency had no significant effect on per-discharge Medicare spending.

To our knowledge, no prior study has examined the impact of integrating both hospitals and PAC participants together in ACOs. A few prior studies have examined the effect of ACOs on PAC outcomes for ACO-attributed patients (Nyweide et al. 2015; McWilliams et al. 2016, 2017). A prior MSSP

evaluation found modest reductions in spending on PAC across attributed Medicare beneficiaries who were discharged to SNF, and a small and non-statistically significant reduction in readmission rates (McWilliams et al. 2017). Similarly, a study of patients attributed to Medicare's Pioneer ACO program found very small reductions in PAC spending for SNF and HH in the first year of the ACO and a small reduction in readmissions that was not statistically significant (Nyweide et al. 2015). Our study asks a different question and takes a different approach. We examine the effect of hospital and PAC provider participation in MSSP ACOs on the post-discharge outcomes across all hospitalized patients (not just patients attributed to an MSSP ACO). Furthermore, while prior studies have estimated the effect of ACO attribution on patient outcomes regardless of whether the patients went to an ACO-participating hospital or PAC provider, we focus on the effect of admission to an ACO-participating provider and focus specifically on whether including both hospitals and PAC providers into ACOs has beneficial effects across all patients.

Accountable care organizations might affect PAC use in two ways—by reducing the overall use of PAC and, conditional on PAC use, using PAC more efficiently. Our study examines the latter mechanism, and suggests that including both hospitals and PAC providers in ACOs creates efficiencies in caring for patients during the post-discharge transition, although the exact mechanism behind improved efficiency is unknown.

One prior study has described PAC participation in ACOs using a national survey of ACOs, reporting that ACOs that included a PAC provider were more likely to report transition management, readmission prevention, and care management capabilities (Colla et al. 2016). The use of these processes at ACOs that include PAC providers might help explain our findings of lower readmission rates for ACOs with SNF participants, and lower Medicare spending on PAC for both SNF and HH agency participants.

It is less likely that the changes in outcomes that we observe are simply due to differences in the types of patients using PAC. We document very similar patient characteristics in each PAC cohort before and after hospitals and PAC providers began participating in ACOs. Additionally, prior work has shown only very small changes in utilization of SNF and HH after ACO implementation for Pioneer ACOs (Nyweide et al. 2015) and for MSSP ACOs (Navathe, Bain, and Werner 2018). Moreover, ACO-driven reductions in PAC use are expected to be among the healthiest patients, leaving the sickest patients in PAC. If the healthiest patients in our sample were forgoing PAC, the remaining sample would have higher readmission rates and

Medicare spending, biasing our results toward zero. Despite this possibility, we find significant effects of ACOs on patient outcomes in SNF.

The effect of ACO participation was strongest for SNFs but was undetectable for IRF. There are several possible explanations for this. As our data show, patients using SNF tend to be sicker than those using HH or IRF and thus may be more sensitive to poor transitions of care. In addition, the lack of an effect for hospitals and IRF participating in ACOs may stem from the tight relationship that typically exists between hospital and IRFs even in the absence of ACOs. Close to 80 percent of IRF are owned by a hospital (MedPAC 2017), and most are located in a hospital, a relationship that might facilitate smoother transitions of care between the two. These tight relationships may have left little room for improved coordination of care in the hospital discharge period.

While the savings we document are largely limited to SNFs, from Medicare's perspective, these savings have the potential to be large. With over 875,000 Medicare beneficiaries using SNF each year, Medicare could potentially save hundreds of millions of dollars annually by more effectively managing hospital-SNF transitions in ACOs. Our study suggests that the observed savings far outpace the $244 million Medicare spent on ACO bonuses under the MSSP contracts during this period, even under one-sided risk contracts that do not allow Medicare to recoup losses from ACOs with high spending levels.

Our study has several limitations. First, as the MSSP ACO programs are voluntary, participating ACO providers may differ from non-participating providers. However, we include hospital fixed effects to control for unobserved time-invariant heterogeneity across hospitals and observe balance in most patient-level factors over time suggesting that hospitals and PAC providers are attracting similar patients whether they are participating in an ACO or not. In addition, the difference-in-differences specification should account for secular trends observed across hospitals under the assumption that the trends across the treatment and control group would have been equal in the absence of ACO participation. Our test of parallel trends supports this assumption, although is tested over only 2 years, which may be a short period over which to observe trends. Second, our study examines the effects of participation in an early subset of MSSP ACOs. Our cohort includes 49 SNFs that participate in an ACO in partnership with a hospital. Whether our results are generalizable beyond this cohort is unknown, but the results are nonetheless an important step in understanding the importance of hospital-PAC partnership in improving patient transitions. Finally, our analysis examines the effect

of ACOs across all Medicare beneficiaries rather than just among beneficiaries attributed to the MSSP ACOs. While we do not directly address the question of what the effect of ACOs is on outcomes for attributed patients, our study does address a broader policy question. That is, can ACOs improve patient outcomes and reduce Medicare spending for all patients, regardless of attribution?

Despite these limitations, our study provides new estimates of the extent of PAC participation in ACOs, and the effects of their participation on patient outcomes and Medicare spending. Ongoing evaluations will be essential in understanding the mechanism by which ACOs change the relationship between hospitals and PAC providers, and how hospital-PAC partners achieve success under this model. But our findings provide important and policy relevant evidence of the importance hospitals and PAC working together to improve patient outcomes.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Appendix SA1: Author Matrix.

Table S1: Thirty-One Comorbidities Included as Covariates in All Regressions.

Table S2: For Patients Discharged to Each PAC Setting, Characteristics of Patients at Hospitals and PACs that Joined and Did Not Join an ACO before and after the Hospitals and PACs Joined the ACOs.

Table S3: Differences in Trends in Outcomes between Hospitals that Ever Join an ACO and Hospitals that Never Join an ACO in Pre-ACO Period (2010–2011).

Table S4: Adjusted Change in Outcomes after a Hospital or Post-Acute Care Provider Joined an ACO, Adjusting for PAC Provider Characteristics*.

Table S5: Characteristics of Hospitals Participating in ACOs and Not in ACOs among a Propensity-Score Matched Cohort of Hospitals, Using 1 : 5 Matching without Replacement.

Table S6: Adjusted Change in Outcomes after a Hospital or Post-Acute Care Provider Joined an ACO in Cohort of Propensity-Score Matched Hospitals.