Published in final edited form as:

Med Care. 2019 June ; 57(6): 444–452. doi:10.1097/MLR.0000000000001121.

Changes in Use of Post-Acute Care Associated with Accountable Care Organizations in Hip Fracture, Stroke, and Pneumonia Hospitalized Cohorts

Carrie H. Colla, Ph.D. [Associate Professor],

The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756, phone: (603)650-3521, fax: (603) 653-0896, Carrie.H.Colla@dartmouth.edu

Valerie A. Lewis, Ph.D.,

Gillings School of Global Public Health, 1103C McGavran-Greenberg Hall, CB #7411, Chapel Hill, NC 27599-7411, The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756

Courtney Stachowski, M.P.H.,

The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756

Benjamin Usadi, M.P.H.,

The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756

Daniel Gottlieb, M.S., and

The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756

Correspondence to: Carrie H. Colla.

Author Information

Carrie H. Colla Ph.D., The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756, phone: (603) 650-3521, fax: (603) 653-0896, Carrie.H.Colla@dartmouth.edu

Valerie A. Lewis Ph.D., Gillings School of Global Public Health, 1103C McGavran-Greenberg Hall, CB #7411, Chapel Hill, NC 27599-7411, phone: (919) 843-8793, lewisv@email.unc.edu

Courtney Stachowski M.P.H., The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756, courtney.stachowski@gmail.com

Benjamin Usadi M.P.H., The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756, phone: (603) 653-0800, fax: (603) 653-0896, Benjamin.Usadi@dartmouth.edu

Daniel Gottlieb M.S., The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756, phone: (603) 653-0800, fax: (603) 653-0896, daniel.j.gottlieb@dartmouth.edu

Julie P.W. Bynum M.D. M.P.H., Department of Internal Medicine, University of Michigan Medical School, Institute for Health Policy and Innovation, University of Michigan, 300 North Ingalls Rd, Rm 933, Ann Arbor, MI 48109-2007, phone: (734) 763-5880, bynumju@med.umich.edu

Conflict of Interest: The authors have no conflicts of interest to report.

Supplementary Digital Content list:

Colla_SDC1.docx; Figure in Microsoft Word. (Study Exclusions)

Colla_SDC2.docx; Text (Methods Appendix) in Microsoft Word

Colla_SDC3.docx; Figure in Microsoft Word (Total Post Acute Spending in Hospitalized Medicare Beneficiaries (30-Days Post-Discharge)

Colla_SDC4.docx; Table in Microsoft Word (Change in Post-Acute Care Spending Associated with ACO Implementation, 2009–2014: ACO Start Period Cohorts)

Julie P.W. Bynum, M.D., M.P.H.

Department of Internal Medicine, University of Michigan Medical School, Institute for Health Policy and Innovation, University of Michigan, 300 North Ingalls Rd, Rm 933, Ann Arbor, MI 48109-2007

The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Level 5, WTRB, 1 Medical Center Drive, Lebanon NH 03756

Abstract

Objective: To examine changes in more and less discretionary condition-specific post-acute care use (skilled nursing, inpatient rehabilitation, home health) associated with Medicare accountable care organization (ACO) implementation.

Data sources: 2009–2014 Medicare fee-for-service claims.

Study Design: Difference-in-difference methodology comparing post-acute outcomes after hospitalization for hip fracture and stroke (where rehabilitation is fundamental to the episode of care) to pneumonia, (where it is more discretionary) for beneficiaries attributed to ACO and non-ACO providers.

Principal Findings: Across all three cohorts, in the baseline period ACO patients were more likely to receive Medicare-paid post-acute care and had higher episode spending. In hip fracture patients where rehabilitation is standard of care, ACO implementation was associated with 6–8% increases in probability of admission to a skilled nursing facility or inpatient rehabilitation (compared to home without care), and a slight reduction in readmissions. In a clinical condition where rehabilitation is more discretionary, pneumonia, ACO implementation was not associated with changes in post-acute location, but episodic spending decreased 2–3%. Spending decreases were concentrated in the least complex patients. Across all cohorts, the length of stay in skilled nursing facilities decreased with ACO implementation.

Conclusions: ACOs decreased spending on post-acute care by decreasing use of discretionary services. ACO implementation was associated with reduced length of stay in skilled nursing facilities, while hip fracture patients used institutional post-acute settings at higher rates. Among pneumonia patients, we observed decreases in spending, readmission days, and mortality associated with ACO implementation.

Keywords

Post-Acute Care; Accountable Care Organizations; cost of care, payment reform, alternative payment models; skilled nursing; post-hospital care

INTRODUCTION

Post-acute care delivery and transitions between settings have been highlighted as areas for improvement in terms of quality and the magnitude and growth in spending (1–3). Post-acute care is used to continue healthcare or rehabilitative services after an acute-hospital stay in order to accelerate recovery and facilitate a smooth transition to the community (4). Hospital discharges to post-acute care facilities increased rapidly throughout the 1990s (5), and by 2013, nearly half of Medicare beneficiaries discharged from hospitals went to a post-

acute care setting (6). An Institute of Medicine report states that 73% of the variation in total Medicare spending is related to post-acute care (3). Much of the variation in post-acute care utilization has been shown to depend on provider discretion, availability, socio-demographic factors such as whether a patient has a caregiver at home, and competition in the post-acute care market (4, 7–9). Researchers and policymakers have hypothesized that increased attention to the coordination of post-acute care holds potential for cost reduction and improved outcomes, particularly under new payment models such as accountable care organizations (ACOs) (10, 11), which are groups of providers held responsible for the cost and quality of care delivered to patients.

Medicare began to implement the ACO model in 2012 when the Pioneer and Medicare Shared Savings Program (MSSP) ACOs began contracts. Since 2012, ACO growth has continued to expand in both the public and private sectors, with over 1,000 ACOs identified today (12). However, ACOs have been slow to formally integrate with post-acute care providers. Half of ACOs include at least one type of post-acute service and one-fifth of ACOs contract with post-acute providers (13). The remainder have no formal relationship with post-acute providers (13).

In this paper, we study the effect of Pioneer and MSSP ACO contracts in hospitalized Medicare beneficiaries with varying post-hospital medical and rehabilitation needs. Early research showed modest reductions in spending on skilled nursing across all ACO patients and that ACO-affiliated hospitals reduced rehospitalizations from skilled nursing facilities (14–16). We build on this work by using clinical cohorts that vary in necessity of post-acute care and use episodes with clinically meaningful covariates and outcomes as the unit of analysis. We study three cohorts: two where rehabilitation in an institutional setting is an evidence-based component of recovery (hip fracture and stroke (17–26)) and one where use of post-acute settings is highly variable and subject to clinical discretion based on the underlying functional status of the patient or the home setting (pneumonia) (27). Research has shown that for eligible stroke patients, intensive settings (IRF) have better outcomes (greater functional gain, more frequent return to community, and lower death rates, (18, 24, 28–33). The evidence on optimal post-acute setting is mixed for hip fracture (18, 24, 30, 34) and little clinical evidence is available for pneumonia. Only those patients with a need for daily skilled services are suitable candidates for institutional post-acute care (e.g. intravenous medications, specialized wound care, tube feeding, respiratory care, physical rehabilitation), and inpatient rehabilitation facilities (IRFs) specifically limit their patient populations based on diagnosis (pneumonia is not an IRF diagnosis) (35, 36).

Conceptual Framework

Case studies and qualitative research indicate that ACOs have begun to implement changes to the discharge process and to manage post-acute care actively and have identified potential mechanisms through which changes may occur (37, 38). In some cases, post-acute settings can act as substitutes for one another, though they have widely differing reimbursement rates. Given ACO contract incentives, care in the most cost-effective setting should be a key consideration for ACOs. Other strategies being used to improve care and reduce spending highlighted include: increased referral to high-quality post-acute care providers (at times

through preferred provider networks), embedded ACO staff within SNFs, provider-to-provider mobile applications and telehealth portals, ACO medical record login privileges for post-acute staff, interdisciplinary patient rounds in post-acute settings, general care coordination across clinicians and settings, and guidelines for identifying appropriate PAC setting (2, 11, 38, 39). Quality measures related to readmissions, care coordination, and patient experience may also drive ACOs to make changes in post-acute management.

We hypothesized that ACO contracts would be associated with reductions in post-acute care spending, reductions in use of institutional settings in favor of home health care, and improvements in rates of return to the community. We hypothesized that results may take different shapes across clinical conditions, depending on guidelines for treatment or the evidence supporting particular settings. We hypothesized larger changes in pneumonia care, where there is more discretion in post-acute treatment protocols and post-acute care is often used due to general morbidity and recovery time, and fewer changes in stroke and hip fracture patients, where rehabilitation of specific functional losses is standard of care.

METHODS

To test our hypotheses, we created three clinical cohorts and corresponding episodes of care and used a difference-in-difference design to compare changes in post-acute care outcomes over the study period for patients attributed to ACOs and non-ACO providers.

Study Population

Community-dwelling beneficiaries enrolled in Medicare fee-for-service Parts A and B comprised our study. From this population, we identified a study sample of beneficiaries first hospitalized with a primary diagnosis of hip fracture, non-transient ischemic attack (TIA) stroke, or pneumonia discharged between January 2009 and December 1, 2014 using the Medpar files. We chose these conditions because they are relatively homogeneous within diagnosis and frequently involve the use of post-acute care (10). Hip fractures and non-TIA stroke cases are nearly always hospitalized, so we would not expect to see differential reductions in hospitalization for this group associated with ACO implementation. Patients were excluded from analysis based on data availability and in an effort to create a homogeneous and clinically meaningful cohort of patients who are expected to rehabilitate after the hospitalization. For example, we excluded patients with a hospital stay less than 3 or greater than 90 days (because these patients are ineligible for Medicare-paid skilled nursing care) and condition-specific clinical exclusions (e.g. TIA for stroke because there is variability in hospitalization rates across areas for this condition). We excluded beneficiaries residing in nursing homes before hospitalization using Minimum Data Set assessments because they would not be expected to return to the community after hospitalization (See Figure, Supplemental Digital Content 1, study exclusions). Because discretion for PAC use among pneumonia patients may differ substantially by severity of diagnosis, we implemented an alternate specification that generated separate estimates for each pneumonia severity level (no complication or comorbidity, complication or comorbidity; major complication or comorbidity), and tested whether severity level modified the ACO effect.

Identifying ACO Patients

The Medicare ACOs in our study joined the program at one of five implementation dates. Thirty-two Pioneer ACOs began in January 2012 and 220 Medicare Shared Savings Program (MSSP) ACOs began in four waves: April 2012 (27), July 2012 (87), January 2013 (106), and January 2014 (124). We used tax identification numbers and National Provider Identifiers to identify ACO participating providers or physicians. Beneficiaries were retrospectively attributed to physician groups in each calendar year based on evaluation and management visits, according to the attribution methodology from the Medicare Shared Savings Program (1, 40). The hospital where the beneficiary was treated did not determine where a patient was attributed; ACO attribution is based on outpatient evaluation and management visit care patterns. Further methodological details on attribution, cohort creation, covariate and outcome specification, and statistical methods are provided in the Methods Appendix (see Text, Supplemental Digital Content 2).

Covariates

To address differences in patient outcomes due to sociodemographic or clinical complexity, we adjust for demographic characteristics (Medicaid status, disability entitlement, age group, gender, race/ethnicity, and proportion in poverty by zip code), Elixhauser (35, 41) comorbidity indicators, presence of a complicated hospital stay (a dichotomous variable defined by any of the following treatments during the hospital stay: intubation and mechanical ventilation, tracheostomy, gastrostomy tube insertion, hemodialysis, enteral or parenteral nutrition, and cardiopulmonary resuscitation) (42), and condition-specific variables (e.g. for hip fracture an indicator for pertrochanteric fracture). Discharging hospital characteristics included: size, ownership status, Medicare patient percentage, case mix index, safety net hospital indicator, teaching status, and participation in the bundled care payment initiative.

Outcomes

We used the following outcome measures: use of post-acute care in 30 days post-hospital discharge (SNF, IRF, home health); length of stay (acute hospital, hospital readmission days, inpatient post-acute care locations, or number of home health visits); total rehabilitation days (combined SNF, IRF and home health); home health days following SNF; total episode spending (acute-hospital stay plus all Parts A and B spending by 30, 120 days post-discharge); total post-acute spending (excluding the acute admission); readmission (30 days); survivors in a community setting on day 120 (defined as not in an inpatient setting including hospital, post-acute or long term nursing facility); and death (30, 120 days).

Statistical Analysis

The level of analysis is a beneficiary acute care hospitalization and the following episode of care. The pre- and post-intervention periods were based on the start date for each ACO. To estimate changes in outcomes associated with ACOs, we compared changes over the ACO implementation period for the ACO group and the control group using a difference-in-difference episode-level model with quarterly time and hospital referral region (HRR) indicators. Quarterly time and HRR fixed effects account for secular trends in length of stay

and local conditions, including penetration of advanced payment models that may affect PAC use. The control group was made up of beneficiaries who were attributed to a non-ACO physician group, and we adjusted for average differences in outcomes between patients attributed to ACOs and those attributed to non-ACO providers at baseline. This design controlled for fixed differences between the controls and ACO groups, as well as biases from comparisons over time in the ACO group that could reflect broader trends in healthcare spending or population health.

We estimated multinomial logistic models for the first location of post-acute care (base category: no use of home health, inpatient rehabilitation, or skilled nursing) and report relative risk ratios, adjusting for covariates as described above. In addition, we estimated a joint significance test for the outcome of location of post-acute care discharge and estimated predicted probabilities of being discharged to each potential post-acute setting. For continuous outcomes we used linear regression and for binary outcomes we used logistic regression and report marginal effects. The effects of interest measure the impact of being assigned to an ACO (relative to controls) during the “post” period, or after the ACO contract begins. This effect was estimated for all ACOs collectively, allowing the date of hospitalization to determine whether it is pre- or post- ACO implementation. The primary specification did not include individual ACO effects; however to model variability in the association between ACO implementation and post-acute spending, we also estimated a model with individual ACO effects. Robust standard errors were used to account for heteroscedasticity.

RESULTS

Descriptive Characteristics

Of patients hospitalized for hip fracture (N=763,069), stroke (N=762,272), and pneumonia (N=1,090,393) who were attributed to a medical group, 24.6% were attributed to an ACO in 2012. In the pre-implementation period, ACO patients more often went to teaching hospitals compared to non-ACO patients (Table 1). Non-ACO patients more often went to smaller hospitals, for-profit hospitals and government-owned hospitals. Across all three cohorts, in the baseline period ACO patients were more likely to receive Medicare-paid post-acute care (Table 2). In the pre-implementation period, outcomes including post-acute care length of stay, 30-day readmissions, and residence in the community were similar in ACO and non-ACO cohorts. Total episode spending was higher in ACO patients than non-ACO patients. In the pre-period, 73% of hip fracture patients used SNF for post-acute care, 13% used home health, and 9% used IRF (Table 3). For stroke patients, 38% used SNF, 21% used home health, and 9% used IRF. In the pneumonia cohort 27% used SNF (31% in the major complication/comorbidity group), 25% used home health, and 1% used IRF. In 2014, 187 SNFs were participating providers in MSSP contracts (i.e. on Medicare participant list), and only 63 (19%) of MSSPs had at least one SNF participating in their ACO contract (not shown in Table).

Multivariate Results

First PAC in 30 Days—ACO implementation was significantly associated with changes in post-acute care location 30 days post-discharge for the hip fracture cohort (Table 3, joint test $p=0.007$). Hip fracture patients attributed to ACOs increased use of skilled nursing facilities (Relative Risk Ratio, RRR (95% CI): 1.063 (1.014, 1.116)) and inpatient rehabilitation facilities post-discharge (1.087 (1.021, 1.157)), compared to receiving no formal care. There were no changes in post-acute settings in the stroke or pneumonia cohorts, or among pneumonia patients by level of severity.

Length of Stay—ACO implementation was associated with a reduction in SNF length of stay (given admission to SNF) for all 3 cohorts (Table 3: marginal effect (95% CI): Hip Fracture -0.137 days(-0.235, -0.040); Stroke -0.198 (-0.353,-0.044); Pneumonia -0.391 (-0.543,-0.239)). The ACO model was associated with decreased IRF length of stay for stroke patients (-0.203 (-0.346, -0.061)) and decreased readmission days for pneumonia patients (-0.108 (-0.208, -0.008)). For those whose first PAC location was SNF, the ACO model was associated with increases in home health days for hip fracture (0.328 (0.187, 0.469)) and pneumonia (0.322 (0.124, 0.520)) cohorts, and increases in probability of any home health: 1.2% (0.6%, 1.8%) for hip fracture cohort and 1.3% (0.4%, 2.1%) for pneumonia, but no change for the stroke cohort (results not shown in table). In the hip fracture and stroke cohorts, ACO implementation was not associated with any change in total post-acute care days within 120 days post-discharge, while in the pneumonia cohort, there was an overall decrease of 0.435 days (-0.674, -0.196, Table 3).

Spending—Across the three study cohorts, the association between ACO implementation and spending varied. There were no significant changes to spending in hip fracture or stroke patients (Table 3). For the pneumonia cohort, the ACO model was associated with decreases of \$335 (95% CI: -435, -236) and \$512 (-721, -302) in 30- and 120-day total episode spending, respectively, as well as and decreases of \$276 (-368, -184) and \$457 (-661, -252) for 30- and 120-day post-acute spending, respectively. Among low-severity (no complication/comorbidity, 19%) and medium severity pneumonia patients (complication/comorbidity, 47%), ACO implementation was associated with decreases in 30-day post-acute spending (low-severity -\$378 (-561, -194) and medium severity -\$329 (-457, -200), while there was no evidence of changes for the major complication or comorbidity group (-\$119 (-288, 49)). Similarly, for low and moderate severity pneumonia, 120-day post-acute spending decreased by \$615 (-1014, -217) and -\$605 (-889, -320)), and there was no evidence of a change for the major complication/comorbidity group (-\$108 (-485, 269)). While on average the association between ACOs and spending was small, across ACOs the association with 30-day post-acute spending varied broadly, with interquartile ranges from \$-669 to \$971, \$-1,242 to \$877, and \$-1,091 to \$419 per patient episode for hip, stroke and pneumonia cohorts, respectively (Figure 1). Post-acute spending trends for each cohort by ACO attribution status and time are presented in supplementary materials (see Figure, Supplemental Digital Content 3, which shows post-acute spending trends by cohort). An alternate specification that estimated the association between ACO implementation and spending for each group of ACOs by start-date (2012 Pioneer, 2012 MSSPs, 2013 MSSPs

and 2014 MSSPs) found that changes in post-acute spending did not differ significantly by start date (see Table, Supplemental Digital Content 4).

Readmission—There was a reduction in readmission rates in both ACOs and non-ACO patients during our study period consistent with the implementation of the Medicare Readmissions Reduction Program (Table 2). There were no significant differences between ACO and non-ACO providers in changes to 30-day readmission rates for stroke or pneumonia patients, but for hip fracture patients, ACO implementation was associated with a reduction in readmission percentage (marginal effect (95% CI): 0.387% (-0.760, -0.015)) (Table 3).

Mortality and Return to Community—ACO implementation was not associated with likelihood of 120-day return to community in survivors in any of the three cohorts (Table 3). The ACO model was associated with a reduction in 30 day and 120 day mortality in the pneumonia cohort (marginal effect (95%CI) -0.584 percentage points (-0.906, -0.262) and -0.231 percentage points (-0.452, -0.010), respectively), but was not associated with 30- or 120-day mortality in the other cohorts.

DISCUSSION

Our study found that ACO implementation was significantly associated with small, subtle changes in use of post-acute care settings. Counter to our hypotheses that ACOs would seek to shift post-acute care out of institutional settings, we did not observe major changes in location of care but rather reductions in length of stay in SNFs: -0.6% in hip fracture, -1.0% in stroke, -2.0% in pneumonia.

While hip fracture patients were more likely to go to institutional settings post-ACO and location of care for stroke patients did not change, in contrast pneumonia patients observed shortening in SNF length of stay and reductions in spending. In each cohort, we observed that the average association across ACOs masked vast differences in changes associated with implementation at the ACO level. Consistent with our hypothesis that the largest changes would occur in the cases with the most clinical discretion we observed changes among pneumonia patients, a cohort in need of nursing but not necessarily rehabilitative care. Within the pneumonia cohort, we observed the decreases in length of stay and spending were concentrated in the lowest severity group. Reductions in mortality associated with ACO implementation in pneumonia patients are promising, indicating that despite lower utilization, mortality has not been adversely affected.

Our study of three narrow cohorts has advantages and disadvantages. We are able to tease out effects for prevalence and location of use (extensive margin) versus the duration and cost of such use (intensive margin) in terms of post-acute use among patient populations who use post-acute care at high rates and with varying provider discretion. Our use of diagnosis-specific cohorts of hospitalized patients that frequently use post-acute care, and 30 and 120 day episodes of care from the date of discharge have advantages over studies of broad groups of beneficiaries. First, we isolate groups for whom rehabilitative care is potentially more and less necessary for disease-specific episodes of care. Second, we study

homogeneous cohorts of patients which reduces opportunities for bias. Finally, we measure outcomes in periods of time consistent with clinical episodes of care.

The associations between ACO implementation and post-acute care use reported in this study for hip fracture tease out nuances from previous research which estimated reductions in skilled nursing facility spending and length of stay overall associated with ACO implementation. Echoing our pneumonia results, early articles noted reductions in skilled nursing spending across all patients (whether or not they had a qualifying hospital stay) of \$12 to \$52 annually, and no differences in rehabilitation or home health spending (14, 16, 43, 44). Our analyses build on this early post-acute care work by using clinical cohorts that vary in necessity of post-acute care and use episodes with clinically meaningful covariates and outcomes as the unit of analysis. Our analysis points to a more nuanced picture that may imply ACOs may be reducing spending on post-acute care in discretionary cases, such as pneumonia, while not altering or adhering more closely to guideline-based care in cohorts that appropriately rely on intense rehabilitation and skilled nursing available in institutional settings. Under the ACO model, the settings of post-acute care are remaining stable over time, but patients are being discharged earlier from SNFs.

Our study has important limitations. The main limitation of our work is the short ACO implementation period, ranging from 1 to 3 years as our data were available through 2014. The short period may limit the opportunity for meaningful institutional change, such as changes to referral patterns. We have not controlled for time varying differences between markets, but our HRR fixed effects force the comparison we are making to be local by definition. The exclusion of nursing home residents from this analysis may potentially bias the results because of regional differences in nursing home utilization. Finally, limits of the data sources preclude inclusion of some patient characteristics, such as caregiver availability or functional status.

An alternative interpretation of our modest results could suggest that ACOs are failing to make meaningful changes in post-acute care use in the first few years of implementation. Overuse in post-acute care is difficult to identify and quantify (45–48); yet research has shown that post-acute care settings act as substitutes for one another, and the cost implications of setting decisions can be large (4, 18). We know there is considerable geographic variation in post-acute care use (3), which is typically interpreted to indicate overuse. A patient's need for skilled versus non-skilled care can be ambiguous in some cases; decisions can depend on caregiver (49) or post-acute setting availability (8) and other non-medical determinants. The opportunity for cost-savings and improved quality of care in the post-acute care setting is rooted in clinically-appropriate discharge settings, emphasis on the coordination of care, the formation of meaningful partnerships and networks, and access to timely, relevant data (2). It is likely that each of these potentially necessary components for efficient use of post-acute care has yet to materialize across ACOs. ACO leaders and policy analysts have called for the relaxation of post-acute payment regulations for diagnostic requirements, length-of-stay rules (3-day hospitalization requirement for SNF reimbursement), and fixed-episode payments to enable greater flexibility based on patient needs and ensure the provision of high-value care (11, 50). Our results support extending further responsibility to providers to care appropriately for varying patient populations, yet

further research is needed on which post-acute care settings are appropriate when and for whom, and on the integration of post-acute care into ACOs to determine how to best facilitate the delivery of high-value care (11).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding Sources and Acknowledgments:

We are grateful for programming support provided by Stephanie Raymond and Lee-Sien Kao. This research was supported by the National Institute on Aging (R33AG044251, P01AG019783, R01AG053307, K01AG049914), the Commonwealth Fund (20160616), The Agency for Healthcare Research and Quality (R01HS024698) and National Center for Advancing Translational Sciences (UL1TR001086).

REFERENCES

1. Chandra A, Dalton MA, Holmes J. Large increases in spending on postacute care in Medicare point to the potential for cost savings in these settings. *Health Aff (Millwood)* 2013;32(5):864–72. [PubMed: 23650319]
2. Mechanic R Post-acute care--the next frontier for controlling Medicare spending. *N Engl J Med* 2014;370(8):692–4. [PubMed: 24552315]
3. Institute of Medicine. Variation in Healthcare Spending: Target decision Making, not Geography. Washington DC:; 2013.
4. Buntin MB, Colla CH, Escarce JJ. Effects of payment changes on trends in post-acute care. *Health Serv Res* 2009;44(4):1188–210. [PubMed: 19490159]
5. Congressional Budget Office. Medicare Spending on Post-Acute Care Services: A Preliminary Analysis. Washington: Congressional Budget Office; 1997.
6. Carter C, Christman E, Kelley D. Post-acute Care: Trends in Medicare's Payments across Sectors and ways to Rationalize Payments: MedPAC; 2015.
7. Colla CH, Escarce JJ, Buntin MB, Sood N. Effects of Competition on the Cost and Quality of Inpatient Rehabilitation Care Under Prospective Payment. *Health services research* 2010;45(6 Pt 2): 1981–2006. [PubMed: 21029086]
8. Buntin MB, Garten AD, Paddock S, Saliba D, Totten M, Escarce JJ. How much is postacute care use affected by its availability? *Health Serv Res* 2005;40(2):413–34. [PubMed: 15762900]
9. Freburger JK, Holmes GM, Ku L-J, Cutchin M, Heatwole-Shank K, Edwards L. Disparities in Post-Acute Rehabilitation Care for Stroke. *Archives of physical medicine and rehabilitation* 2011;92(8): 1220–1229. [PubMed: 21807141]
10. Sood N, Huckfeldt PJ, Escarce Jé J, Grabowski DC, Newhouse JP. Medicare's Bundled Payment Pilot for Acute and Postacute Care: Analysis and Recommendations on Where to Begin. *Health Aff (Millwood)* 2011;30(9):1708–17. [PubMed: 21900662]
11. Ackerly DC, Grabowski DC. Post-Acute Care Reform — Beyond the ACA. *New England Journal of Medicine* 2014;370(8):689–691. [PubMed: 24552314]
12. Muhlestein DS, Richards R, McClellan R. Recent Progress In The Value Journey: Growth of ACOs and Value-Baed Payment Models In 2018. *Health Affairs Blog* 2018.
13. Colla CH, Lewis VA, Bergquist SL, Shortell SM. Accountability across the Continuum: The Participation of Postacute Care Providers in Accountable Care Organizations. *Health Serv Res* 2016;51(4):1595–611. [PubMed: 26799992]
14. Nyweide DJ, Lee W, Cuerdon TT, et al. Association of Pioneer Accountable Care Organizations vs Traditional Medicare Fee For Service with Spending, Utilization, and Patient Experience. *JAMA* 2015;313(21):2152–2161. [PubMed: 25938875]

15. Winblad U, Mor V, McHugh JP, Rahman M. ACO-Affiliated Hospitals Reduced Rehospitalizations From Skilled Nursing Facilities Faster Than Other Hospitals. *Health Aff (Millwood)* 2017;36(1): 67–73. [PubMed: 28069848]
16. McWilliams JM, Gilstrap LG, Stevenson DG, Chernew ME, Huskamp HA, Grabowski DC. Changes in Postacute Care in the Medicare Shared Savings Program. *JAMA Intern Med* 2017;177(4):518–526. [PubMed: 28192556]
17. Handoll HH, Cameron ID, Mak JC, Finnegan TP. Multidisciplinary rehabilitation for older people with hip fractures. *Cochrane Database Syst Rev* 2009(4):Cd007125. [PubMed: 19821396]
18. Buntin MB, Colla CH, Deb P, Sood N, Escarce JJ. Medicare spending and outcomes after postacute care for stroke and hip fracture. *Med Care* 2010;48(9):776–84. [PubMed: 20706167]
19. Handoll HH, Sherrington C, Mak JC. Interventions for improving mobility after hip fracture surgery in adults. *Cochrane Database Syst Rev* 2011(3):Cd001704. [PubMed: 21412873]
20. Stott DJ, Handoll HH. Rehabilitation of older people after hip (proximal femoral) fracture. *Cochrane Database Syst Rev* 2011(8):Ed000023. [PubMed: 21833982]
21. Freburger JK, Holmes GM, Ku LJ. Postacute rehabilitation care for hip fracture: who gets the most care? *J Am Geriatr Soc* 2012;60(10):1929–35. [PubMed: 23036079]
22. Langhorne P, Duncan P. Does the organization of postacute stroke care really matter? *Stroke* 2001;32(1):268–74. [PubMed: 11136947]
23. Lincoln NB, Husbands S, Trescoli C, Drummond AE, Gladman JR, Berman P. Five year follow up of a randomised controlled trial of a stroke rehabilitation unit. *Bmj* 2000;320(7234):549. [PubMed: 10688561]
24. Kramer AM, Steiner JF, Schlenker RE, Eilertsen TB, Hrinkevich CA, Tropea DA, et al. Outcomes and costs after hip fracture and stroke. A comparison of rehabilitation settings. *Jama* 1997;277(5): 396–404. [PubMed: 9010172]
25. Gresham GE D P, Stason WB, Adams HP Jr, Adelman AM, Alexander DN B D, Diller L, Donaldson NE, Granger CV. Post-stroke rehabilitation. Clinical practice guideline, no. 16. In. Rockville, MD; 1995.
26. Duncan PW, Horner RD, Reker DM, Samsa GP, Hoenig H, Hamilton B, et al. Adherence to postacute rehabilitation guidelines is associated with functional recovery in stroke. *Stroke* 2002;33(1):167–77. [PubMed: 11779907]
27. Marsh CA. Post-acute Care (PAC): Placement and Outcomes for Medicare Beneficiaries with a Pneumonia Diagnosis: Brandeis University; 2015.
28. Jette DU, Warren RL, Wirtalla C. Rehabilitation in skilled nursing facilities: effect of nursing staff level and therapy intensity on outcomes. *Am J Phys Med Rehabil* 2004;83(9):704–12. [PubMed: 15314535]
29. Kane RL, Chen Q, Blewett LA, Sangl J. Do rehabilitative nursing homes improve the outcomes of care? *J Am Geriatr Soc* 1996;44(5):545–54. [PubMed: 8617903]
30. Kane RL, Chen Q, Finch M, Blewett L, Burns R, Moskowitz M. Functional outcomes of posthospital care for stroke and hip fracture patients under medicare. *J Am Geriatr Soc* 1998;46(12):1525–33. [PubMed: 9848813]
31. Kane RL, Chen Q, Finch M, Blewett L, Burns R, Moskowitz M. The optimal outcomes of post-hospital care under medicare. *Health Serv Res* 2000;35(3):615–61. [PubMed: 10966088]
32. Keith RA, Wilson DB, Gutierrez P. Acute and subacute rehabilitation for stroke: a comparison. *Arch Phys Med Rehabil* 1995;76(6):495–500. [PubMed: 7763146]
33. Kramer AM, Kowalsky JC, Lin M, Grigsby J, Hughes R, Steiner JF. Outcome and utilization differences for older persons with stroke in HMO and fee-for-service systems. *J Am Geriatr Soc* 2000;48(7):726–34. [PubMed: 10894309]
34. Munin MC, Seligman K, Dew MA, Quear T, Skidmore ER, Gruen G, et al. Effect of rehabilitation site on functional recovery after hip fracture. *Arch Phys Med Rehabil* 2005;86(3):367–72. [PubMed: 15759213]
35. CMS. Medicare Benefit Policy Manual: Chapter 8 - Coverage of Extended Care (SNF) Services Under Hospital Insurance. In: CMS; 2016.
36. CMS. Fact Sheet #1: Inpatient Rehabilitation Facility Classification Requirements. In: CMS.

37. Ackerly DC. Post-Acute Care Can Help Accountable Care Organizations Save. In: RevCycle Intelligence; 2016.
38. Kennedy G, Lewis VA, Kundu S, Mousques J, Colla CH. Accountable Care Organizations and Post-Acute Care: A Focus on Preferred SNF Networks. *Med Care Res Rev* 2018;1077558718781117.
39. Lage DE, Rusinak D, Carr D, Grabowski DC, Ackerly DC. Creating a network of high-quality skilled nursing facilities: preliminary data on the postacute care quality improvement experiences of an accountable care organization. *J Am Geriatr Soc* 2015;63(4):804–8. [PubMed: 25900492]
40. CMS. Medicare Shared Savings Program: Shared Savings and Losses and Assignment Methodology. In: Centers for Medicare and Medicaid Services; 2014.
41. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care* 1998;36(1):8–27. [PubMed: 9431328]
42. Barnato AE, Farrell MH, Chang CC, Lave JR, Roberts MS, Angus DC. Development and validation of hospital “end-of-life” treatment intensity measures. *Med Care* 2009;47(10):1098–105. [PubMed: 19820614]
43. McWilliams JM, Hatfield LA, Chernew ME, Landon BE, Schwartz AL. Early Performance of Accountable Care Organizations in Medicare. *N Engl J Med* 2016;374(24):2357–66. [PubMed: 27075832]
44. Colla CH, Lewis VA, Kao LS, O’Malley AJ, Chang CH, Fisher ES. Association Between Medicare Accountable Care Organization Implementation and Spending Among Clinically Vulnerable Beneficiaries. *JAMA Intern Med* 2016;176(8):1167–75. [PubMed: 27322485]
45. Harder B C A. Tying Our Nursing Home Ratings to Overuse of Rehabilitation. *U.S. News & World Report* 3 18, 2016.
46. Golden AG, Martin S, da Silva M, Roos BA. Care management and the transition of older adults from a skilled nursing facility back into the community. *Care Manag J* 2011;12(2):54–9. [PubMed: 21717847]
47. Carter C, Garrett AB, Wissoker D. Reforming Medicare payments to skilled nursing facilities to cut incentives for unneeded care and avoiding high-cost patients. *Health Aff (Millwood)* 2012;31(6):1303–13. [PubMed: 22665843]
48. Doyle J G J, Gruber J. Uncovering Waste in U.S. Healthcare. In: Research TNBoE, editor.; 2015.
49. Roth DL, Sheehan OC, Huang J, Rhodes JD, Judd SE, Kilgore M, et al. Medicare claims indicators of healthcare utilization differences after hospitalization for ischemic stroke: Race, gender, and caregiving effects. *Int J Stroke* 2016;11(8):928–934. [PubMed: 27435204]
50. CMS. Post-Discharge Home Visits. In: <https://innovation.cms.gov/files/x/nextgenacopdhomevisitwaiver.pdf>; 2016.

Figure 1. Heterogeneity in Adjusted 30 day PAC Spending Changes Among ACOs.

Notes: Changes in total spending associated with ACO implementation were estimated for the interactions of postperiod status with individual ACO indicators. Each circle represents the association between ACO implementation and 30 day post-acute care spending for one ACO (the coefficient on the ACO fixed effect-post period interaction term). ACOs with fewer than 20 observations in any year were removed from this model. ACOs with large swings in participating providers in years before ACO implementation were removed from analysis (N=3).

Table 1.

Demographic Measures Related to Post-Acute Care, 2009–2014

	Hip Fracture				Stroke				Pneumonia			
	Non-ACO		ACO		Non-ACO		ACO		Non-ACO		ACO	
	Pre [§]	Post	Pre	Post	Pre [§]	Post	Pre	Post	Pre [§]	Post	Pre	Post
N	376,789	185,929	141,053	59,298	379,654	177,316	146,627	58,675	555,497	251,567	204,151	79,178
Demographics	%	%	%	%	%	%	%	%	%	%	%	%
Age (years), mean	83.4	83.6	83.6	83.7	80.3	80.4	80.3	80.7	80.4	80.6	80.6	80.9
Female	73.8	73.4	74.0	73.7	58.5	59.0	58.7	59.0	55.8	56.5	56.3	56.7
Black	3.1	3.1	3.0	2.7	10.5	10.7	10.4	9.3	6.4	6.7	6.4	5.9
Hispanic	3.1	3.3	3.4	3.7	4.7	4.7	5.1	5.6	4.4	4.6	4.9	5.2
Disabled	8.1	8.8	7.4	7.8	11.5	12.2	10.3	10.7	14.9	16.1	13.7	14.5
Medicaid eligible	14.4	15.2	13.2	13.9	17.2	17.4	15.9	16.5	19.4	20.8	18.2	19.1
Discharging Hospital	%	%	%	%	%	%	%	%	%	%	%	%
<150 beds	24.7	24.5	20.2	19.6	19.9	18.1	14.8	14.0	36.4	35.5	25.8	25.5
Major teaching *	7.3	8.1	12.2	13.2	12.2	13.4	17.6	19.8	6.4	6.7	11.5	11.8
Government	13.6	13.6	8.7	8.0	14.7	14.6	9.4	8.3	17.2	17.1	10.1	9.0
For-profit	16.3	15.5	12.8	12.7	15.3	14.5	12.3	12.3	16.3	16.3	12.7	13.4
% Medicare Discharges	41.3	40.9	39.8	39.9	40.6	39.9	39.1	38.8	44.6	44.2	41.6	41.8
Case mix index, mean	1.580	1.590	1.600	1.600	1.610	1.630	1.640	1.640	1.470	1.490	1.550	1.540
Safety net [†]	48.2	48.9	46.5	44.8	53.4	54.7	52.2	51.5	45.8	46.0	45.6	43.5
Complicated hospital stay [‡]	3.4	3.2	3.6	3.5	11.6	11.8	11.6	11.8	3.5	3.9	3.8	4.1

* A teaching hospital is defined as a major teaching hospital if it has a resident per bed ratio of greater than 25%.

[†] A safety net hospital is defined as a disproportionate-share hospital patient percentage of greater than or equal to 20%.

[‡] A complicated stay is a dichotomous variable defined by any of the following life-sustaining treatments during the hospital stay: intubation and mechanical ventilation, tracheostomy, gastrostomy tube insertion, hemodialysis, enteral or parenteral nutrition, and cardiopulmonary resuscitation as defined in Barnato et al. 2009.

[§] Pre-period for control observations defined as before January 1, 2013.

We compared differences between ACO and non-ACO provider patients in the pre-period using comparison of mean tests.

Table 2.

Outcome Measures Related to Post-Acute Care, 2009–2014

	Hip Fracture				Stroke				Pneumonia			
	Non-ACO		ACO		Non-ACO		ACO		Non-ACO		ACO	
	Pre [†]	Post	Pre	Post	Pre [†]	Post	Pre	Post	Pre [†]	Post	Pre	Post
First PAC use [*]	%	%	%	%	%	%	%	%	%	%	%	%
SNF	70.9	71.9	72.6	74.5	39.2	40.8	38.5	40.2	26.6	29.4	27.3	30.0
Home health	14.0	13.1	12.9	11.5	20.6	19.6	21.1	20.4	24.1	24.2	25.6	26.1
IRF	8.3	7.5	8.6	8.0	8.4	8.9	8.8	9.3	0.9	1.1	0.9	1.0
No post-acute care	6.8	7.5	5.9	6.0	31.8	30.6	31.5	30.1	48.5	45.4	46.2	42.9
Length of Stay (days)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Acute hospital admission	5.8 (3.4)	5.5 (3.1)	5.8 (3.4)	5.4 (3.0)	6.3 (4.9)	6.1 (4.8)	6.2 (5.0)	6.0 (4.8)	5.7 (3.4)	5.6 (3.3)	5.7 (3.4)	5.5 (3.2)
Hospital (post-discharge) [‡]	5.9 (4.4)	5.6 (4.3)	5.8 (4.4)	5.6 (4.2)	5.7 (4.7)	5.5 (4.6)	5.6 (4.6)	5.6 (4.7)	6.1 (4.6)	6.0 (4.5)	6.1 (4.6)	5.8 (4.5)
SNF	22.9 (8.5)	23.3 (8.4)	23.3 (8.3)	23.1 (8.4)	19.7 (9.7)	20.0 (9.6)	19.8 (9.6)	19.5 (9.6)	19.1 (9.6)	20.3 (9.2)	19.6 (9.3)	19.8 (9.2)
Home health	7.4 (4.3)	7.2 (4.1)	7.2 (4.2)	6.9 (4.1)	8.1 (4.8)	7.8 (4.5)	8.1 (4.8)	7.8 (4.5)	8.4 (4.9)	8.2 (4.7)	8.3 (5.0)	8.1 (4.8)
IRF	14.1 (5.7)	14.1 (5.6)	14.0 (5.4)	14.1 (5.2)	15.7 (7.4)	15.6 (7.2)	15.9 (7.3)	15.6 (7.1)	9.5 (6.4)	9.6 (6.2)	10.1 (6.2)	10.2 (6.1)
Spending - 30 days (\$)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Total PAC	17,896 (11,046)	17,119 (10,969)	18,249 (10,909)	17,707 (10,858)	15,705 (15,559)	15,766 (15,382)	16,230 (15,989)	16,417 (15,966)	7,390 (10,112)	7,849 (10,282)	7,732 (10,392)	8,025 (10,406)
Total Episode	30,541 (13,228)	30,414 (13,010)	31,365 (13,358)	31,601 (13,260)	25,490 (21,662)	26,191 (21,921)	26,512 (22,598)	27,632 (23,513)	13,742 (11,149)	14,710 (11,408)	14,373 (11,448)	15,167 (11,496)
Spending - 120 Days (\$)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Total PAC	31,294 (21,745)	29,155 (20,525)	32,136 (22,272)	30,704 (21,380)	28,264 (28,593)	27,477 (27,394)	29,196 (29,664)	29,014 (29,423)	17,238 (21,839)	17,250 (21,317)	18,192 (23,053)	18,121 (22,359)
Total Episode	43,931 (23,506)	42,433 (22,224)	45,244 (24,216)	44,601 (23,302)	38,035 (33,620)	37,878 (32,897)	39,465 (35,215)	40,299 (36,019)	23,583 (22,656)	24,095 (22,202)	24,825 (23,894)	25,256 (23,232)
Readmissions 30 Days (%)	14.5	12.6	14.6	12.6	16.2	14.7	16.3	14.8	17.7	16.5	17.9	16.5
Community Setting (%) 120 Days (among survivors)	83.2	86.2	83.7	87.6	82.2	84.9	83.0	85.9	89.2	90.5	89.4	90.8
Death 30 Days (%)	4.9	5.2	4.7	4.8	10.1	10.8	9.3	10.2	7.3	8.1	6.9	7.4
Death 120 Days (%)	13.3	13.3	12.6	12.5	18.2	18.6	17.1	17.9	16.7	17.6	16.1	16.4

^{*} For analysis of first PAC location, observations with first PAC at long-term care hospital were removed, due to the small number of these observations.

[‡] Pre-period for control observations defined as before January 1, 2013.

SNF=Skilled nursing facility; IRF=Inpatient rehabilitation hospital; PAC=post-acute care

Defined as number of days readmitted to hospital within 30 days after initial discharge from cohort-defining admission.
*We compared differences between ACO and non-ACO provider patients in the pre-period using comparison of mean tests.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3: Change in Use of Post-Acute Care Associated with ACO Implementation, 2009–2014[†]

	Hip Fracture		Stroke		Pneumonia	
	ACO Pre-Period	Relative Risk Ratio (95% CI)	ACO Pre-Period	Relative Risk Ratio (95% CI)	ACO Pre-Period	Relative Risk Ratio (95% CI)
First PAC in 30 days (compared to No Formal Care)	%	p=0.007	%	p=0.954	%	p=0.955
Joint test for all PAC locations						
Skilled nursing facility	72.6	1.063 [*] (1.014 to 1.116)	38.5	0.998(0.970 to 1.027)	27.3	1.000 (0.976 to 1.025)
Home health agency	12.9	1.020(0.965 to 1.079)	21.1	0.996(0.964 to 1.029)	25.9	1.004 (0.980 to 1.029)
Inpatient rehab facility	8.6	1.087 ^{**} (1.021 to 1.157)	8.8	1.009(0.965 to 1.056)	0.9	0.980 (0.888 to 1.082)
Length of Stay (days)[#]	Mean (SD)	Marginal Effect(95% CI)	Mean (SD)	Marginal Effect(95% CI)	Mean (SD)	Marginal Effect(95% CI)
Acute hospital admission	5.8 (3.4)	-0.012(-0.042 to 0.018)	6.2 (5.0)	0.008(-0.033 to 0.049)	5.7 (3.4)	-0.024 (-0.052 to 0.005)
Hospital (post-discharge) [‡]	5.8 (4.4)	-0.045(-0.169 to 0.080)	5.6 (4.6)	0.124(0.000 to 0.248)	6.1 (4.6)	-0.108 [*] (-0.208 to -0.008)
Skilled nursing facility [§]	23.3 (8.3)	-0.137 ^{**} (-0.235 to -0.040)	19.8 (9.6)	-0.198 [*] (-0.353 to -0.044)	19.6 (9.3)	-0.391 ^{***} (-0.543 to -0.239)
Home health agency [§]	7.2 (4.2)	0.044(-0.035 to 0.123)	8.1 (4.8)	0.010(-0.080 to 0.100)	8.3 (5)	0.049 (-0.026 to 0.124)
Inpatient rehab facility [§]	14 (5.4)	0.037(-0.077 to 0.151)	15.9 (7.3)	-0.203 ^{**} (-0.346 to -0.061)	10.1 (6.2)	0.125(-0.128 to 0.379)
Total Post-Acute Care Days (within 120 days post-discharge)	48.5(32.4)	-0.303(-0.641 to 0.305)	31.9(35.3)	-0.335(-0.709 to 0.038)	18.5(26.5)	-0.435 ^{***} (-0.674 to -0.196)
Total Episode Spending (\$ 30 days)	31,365 (13,358)	58(-69 to 185)	26,512 (22,598)	-7(-209 to 195)	14,373 (11,448)	-335 ^{***} (-435 to -236)
Total Episode Spending (\$ 120 days)	45,244 (24,216)	85(-154 to 324)	39,465 (35,215)	86(-253 to 425)	24,825 (23,894)	-512 ^{***} (-721 to -302)
Total Post-Acute Spending (\$ 30 days)	17,896 (11,046)	0(-112, 111)	16,230 (15,989)	-139(-301 to 22)	7,732 (10,392)	-276 ^{***} (-368 to -184)
Total Post-Acute Spending (\$ 120 days)	31,294 (21,745)	24(-204, 251)	29,196 (29,664)	-82(-388 to 224)	18,192 (23,053)	-457 ^{***} (-661 to -252)
	%		%		%	
Any Readmission 30 days (%)	14.6	-0.387 [*] (-0.760 to -0.015)	16.3	-0.187(-0.578 to 0.205)	17.9	-0.343(-0.690 to 0.005)
Community Setting 120 days (%)	83.7	-0.539(-1.102 to 0.024)	83.0	-0.549(-1.127 to 0.029)	89.4	0.028(-0.362 to 0.418)
Death 30 days (%)	4.7	-0.081(-0.300 to 0.137)	9.3	0.100(-0.197 to 0.397)	6.9	-0.231 [*] (-0.452 to -0.010)
Death 120 days (%)	12.6	-0.159(-0.510 to 0.193)	17.1	0.038(-0.352 to 0.428)	16.1	-0.584 ^{***} (-0.906 to -0.262)

⁷ Linear regression models were used to estimate effects for the following outcomes: total episode spending, total post-acute spending, and length of stay. Logistic models were used to estimate effects for the following outcomes: readmission, community setting, and death. A multinomial logistic regression model was used to estimate effects for first post-acute care use in 30 days.

Marginal effects for readmission, community setting and mortality variables are shown as percentage changes.

*** p<0.001,
** p<0.01,
* p<0.05

[‡] Defined as length of stay in hospital within 30 days after initial discharge for cohort-defining admission.

[#] 30 day maximum.

[§] Estimated only for those with such PAC use.

Table 4:

Change in Use of Post-Acute Care Associated with ACO Implementation for Pneumonia Severity-level[‡] Cohorts, 2009–2014

	ACO Pre-Period Mean(SD)	Marginal Effect (95% CI)
Length of Stay (days) Skilled nursing facility [†]		
No complication or comorbidity	19.6 (9.4)	−0.974(−1.379 to −0.570) ***
Complication or comorbidity	19.7 (9.3)	−0.374(−0.597 to −0.152) ***
Major complication or comorbidity	19.6 (9.4)	−0.158(−0.397 to 0.081)
Total Episode Spending (\$) 30 days		
No complication or comorbidity	9,526 (8,825)	−460(−654 to −266) ***
Complication or comorbidity	13,364 (10,476)	−393(−528 to −258) ***
Major complication or comorbidity	18,278 (12,546)	−144(−323 to 35)
Total Episode Spending (\$) 120 days		
No complication or comorbidity	16,624 (18,446)	−701(−1107 to −296) ***
Complication or comorbidity	23,389 (22,243)	−662(−951 to −374) ***
Major complication or comorbidity	31,072 (26,694)	−123(−507 to 261)
Total Post-Acute Spending (\$) 30 days		
No complication or comorbidity	5,395 (8,369)	−378(−561 to −194) ***
Complication or comorbidity	7,370 (9,873)	−329(−457 to −200) ***
Major complication or comorbidity	9,451 (11,629)	−119(−288 to 49)
Total Post-Acute Spending (\$) 120 days		
No complication or comorbidity	12,495 (18,130)	−615(−1014 to −217) **
Complication or comorbidity	17,402 (21,785)	−605(−889 to −320) ***
Major complication or comorbidity	22,254 (25,996)	−108(−485 to 269)

[†] Among those with SNF admission

[‡] Major complication or comorbidity represents DRG code 193; Complication or comorbidity represents DRG code 194; No complication or comorbidity represents DRG code 195.

p<0.001,

**
p<0.01,

*
p<0.05

Linear regression models were used to estimate spending and length of stay outcomes. Tests for interaction effects revealed no evidence that severity level modified effects for mortality, return to community, first PAC location, or non-SNF length of stay outcomes.