Published in final edited form as:

Med Care Res Rev. 2020 December ; 77(6): 549–558. doi:10.1177/1077558718818336.

Hospitals Strengthened Relationships with Close Partners After Joining Accountable Care Organizations

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Abstract

The strategies that hospitals participating in Medicare Accountable Care Organizations use to achieve quality and cost containment goals are poorly understood. One possibility is that participating hospitals could try to influence where their patients receive care. To test this hypothesis, we examined whether a hospital's participation in a Medicare ACO was associated with changes in its patterns of patient sharing with other hospitals. Between 2010 and 2014, patient sharing across hospitals increased 23.3%. After controlling for hospital and regional factors, patient sharing increased 4.4% more at ACO hospitals than non-ACO hospitals ($P=0.001$ for difference). This increase occurred disproportionately among hospitals with which ACO hospitals already shared a high proportion of their patients prior to participation, and among hospitals in ACOs characterized as physician-hospital collaborations. The increased sharing of patients among closely affiliated hospitals may serve to achieve ACO quality and cost containment goals through increased inter-organizational coordination.

Keywords

Health Care Organization; Health Policy; Hospitals; Medicare; Referral Networks

Introduction

Providers in Medicare Accountable Care Organizations (ACOs) are responsible for the quality and cost of care delivered to their assigned beneficiaries (Berwick, 2011; Fisher & Shortell, 2010; McClellan, McKethan, Lewis, Roski, & Fisher, 2010). With expenditures on inpatient care accounting for nearly one third of all fee-for-service spending (Control & Prevention, 2016), engagement with hospitals is important to achieve the dual goals of quality improvement and cost containment. Recognizing this, nearly half of ACOs in the Medicare Shared Savings Program and Pioneer model include hospital participants (Colla, Lewis, Tierney, & Muhlestein, 2016). One important way through which ACOs could

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Conflicts: We have no conflicts to report.

influence the quality and efficiency of inpatient care is by altering relationships between hospitals participating in ACOs and the other hospitals with which they share patients.

Although by law Medicare ACOs cannot explicitly restrict where patients receive care, their collective incentives may shift how hospitals view their relationships with other facilities (Gold, 2014; Song et al., 2011). ACO participation may therefore lead hospital leaders to pursue strategies that disrupt existing routines of patient transfer and referral (Iwashyna, Kahn, Hayward, & Nallamothu, 2010) by encouraging physicians to alter where they refer their patients and by encouraging patients to make certain choices about where to go for care (Bosk, Veinot, & Iwashyna, 2011; Gold, 2014; Song et al., 2011). Specifically, hospitals in ACOs may more directly view other hospitals as competitors and sources of potential inefficiency. In consequence, ACO-participating hospitals may seek to limit all patient leakage—the extent to which their patients are treated by any other facilities—to ensure continuity of care and to contain costs by keeping patients within their organization, where they hold most control (McWilliams, Chernew, Dalton, & Landon, 2014; Sinaiko & Rosenthal, 2010). Alternatively, hospitals in ACOs may view hospitals with which they have close relationships as important partners in pursuing efficient, high-quality care and seek to strengthen existing relationships. In this case, they might pursue strategies that encourage certain patients to go to trusted facilities that they believe provide lower cost and/or higher quality service for that patient, resulting in improved performance for the ACO (Song et al., 2011) while deepening ties among specific, important partners to support information sharing, enhance care coordination and efficiently allocate patients (Haggerty et al., 2003; Paulraj, Lado, & Chen, 2008; Zollo, Reuer, & Singh, 2002).

Importantly, the ability of an ACO to alter hospital relationships likely depends on its organizational structure (McWilliams, Hatfield, Chernew, Landon, & Schwartz, 2016; Shortell, Wu, Lewis, Colla, & Fisher, 2014). While in some cases physician-led ACOs have performed best on the measures of spending and quality by which these organizations are assessed (McWilliams et al., 2016), ACOs that are collaborative efforts led by both hospitals and physicians may be most effective at influencing collaborative patterns between hospitals. These hospital-physician collaborations are likely to hold an advantage because they may most easily integrate changes in hospital policy and physician referral behavior. In contrast, hospital-led ACOs may have less ability to influence physician referral behavior, and physician-led ACOs may have less ability to influence hospital policy around transfers and referrals.

To better understand the effect of ACO participation on relationships between hospitals, we analyzed data from all Medicare fee-for-service beneficiaries treated at multiple hospitals between 2010 and 2014. Using volume of shared patients as the measure of hospital relationships, we sought to answer three research questions. First, do hospitals weaken or strengthen relationships with other hospitals after joining an ACO? Second, to the extent that hospital relationships change, is that change focused in altering relationships with closely or peripherally connected hospitals? Finally, are some types of ACOs better able to influence these relationships than others?

New Contribution

While some prior work has focused on the degree of ‘leakage’ among ACOs, we know of none that investigated the influence of ACO participation on inter-organizational relationships. Findings from our analysis provide evidence about how public policy influences relationships between hospitals, which is an important marker of how these programs alter the competitive and collaborative nature of the healthcare delivery system. Our findings also inform ongoing inquiries into the strategies necessary for reforms to result in improved care quality and efficiency, and how these reforms influence the competitive and collaborative environment. Finally, we also contribute to the literature on provider networks of shared patients, which has generally pursued cross-sectional analysis, by examining how public policy can drive change in the structure of those networks.

Conceptual Model

In Medicare’s fee-for-service system, reimbursement is based on the volume of patients that providers treat and the complexity of care provided, such that providers are incentivized to retain patients. When patients are treated elsewhere, providers often have little financial motive to attend to the outside organizations that care for their patients because the cost or quality of care delivered outside their walls does not have an impact on the provider. In consequence, the referral and transfer system does not appear to be well organized: physicians refer to other physicians that are similar to them in some observable characteristic, a preference known as homophily (Landon et al., 2012). Meanwhile, referrals and transfers between hospitals do not appear to be based solely on observable volume or quality but rather reflect a pattern of routines or habit (Dudley, Johansen, Brand, Rennie, & Milstein, 2000; Iwashyna et al., 2010).

Medicare’s ACO model creates incentives for providers to consider where their patients are treated by assigning them beneficiaries and basing shared savings payments on the cost and quality of care delivered to their beneficiaries, including the care received outside of the ACO. This dynamic could lead ACO participants away from routine- and homophily-based referral and transfer patterns and towards more intentional approaches (McWilliams et al., 2017). However, it is not clear how hospitals will react. One approach would be to keep patients within the ACO. This could be advantageous by increasing the ACO’s ability to monitor their patient population’s health, compliance with clinical guidelines, and ensure duplicative tests or procedures are not performed (Noble & Casalino, 2013). Similarly, continuity of care is often associated with better patient outcomes (Frandsen, Joynt, Rebitzer, & Jha, 2015; Van Walraven, Oake, Jennings, & Forster, 2010). However, recent evidence indicates that ACOs may not be successfully limiting leakage from their organization (Barnett & McWilliams, 2018), and limiting leakage may be particularly hard in the case of hospital care.

Alternatively, quality and cost incentives could motivate ACO hospitals to seek to increase patient movement to outside hospitals when other settings provide more valuable care. This approach could provide allocative efficiency in patient care, leading to greater savings to Medicare and the ACO. However, increased movement may also lead to care coordination challenges. Focusing patient movement in specific outside hospitals promises to ameliorate

those challenges: high volume, concentrated relationships could serve as the basis for experiential learning to develop coordination between organizations, relational coordination between staff, and the ability to focus investment in interoperability in those specific outside hospitals with which they seek to share patients (Gittel et al., 2000; Halm, Lee, & Chassin, 2002; Hoffer Gittel, 2002; Holmqvist, 2004; Unertl, Johnson, Gadd, & Lorenzi, 2013). Further, hospitals that are newly concerned about where else their patients receive care may prefer that their patients are treated at hospitals with which they have an established relationship and trust. Therefore, hospitals may face a particular incentive to increase sharing with frequent partners, facilitating coordinated care with these hospitals across several dimensions. Data on how ACO hospitals are responding to changing incentives could, therefore, shed light on the strategies these organizations are pursuing to achieve higher quality and whether this is resulting in more closed systems or more collaboration across organizations.

Methods

Data Source

To measure relationships between hospitals, we created a panel of hospitals covering the years 2010 to 2014 using the “Physician Shared Patient Patterns” files (Centers for Medicare and Medicaid Services). Released by the Centers for Medicare and Medicaid Services (CMS), these files are derived from national inpatient, outpatient, and other claims types. Patient sharing occurs when “an organization or provider participates in the delivery of health services to the same patient within 30 days ... after another organization or provider participated in providing health services to the same patient (Centers for Medicare and Medicaid Services).” This type of relationship has been previously used to measure collaborative relationships between hospitals (Mascia & Di Vincenzo, 2013) and physicians (Barnett, Landon, O’malley, Keating, & Christakis, 2011; Everson et al., 2017). We merged this data with the American Hospital Association (AHA) Annual Survey to identify hospital organizations and their characteristics within the patient sharing file.

We then combined the shared patient data with data on hospital Medicare Shared Savings or Pioneer ACO participation from Leavitt Partners ACO Database, which has previously been used to define participation in ACOs (Colla et al., 2016; Muhlestein, Tu, de Lisle, & Merrill, 2016).ⁱ Information on ACOs in this database is updated regularly from press releases, news articles, government announcements, conferences, personal and industry interviews, and other public records. We also used data from the Area Health Resource File and CMS’ report on Hospital Case Mix from the acute inpatient updates to capture a broader set of hospital characteristics (Centers for Medicare and Medicaid Services).

ⁱWhile other researchers have used this data source for analysis, the source has not been systematically validated. We consider using alternative data sources and investigated use of the Medicare provider ACO file; however, this alternative may not reliably capture hospital ACO participation when the hospital’s medical group, rather than the hospital itself, participates. Given these limitations, we believe that the Leavitt data is the best available source of data on hospital participation in ACOs.

Population

Our analysis focused on all non-federal, acute-care hospitals in the U.S. To be included in our analysis, hospitals had to be listed in the AHA Survey for all five years of the study period and to have shared Medicare patients with at least one other hospital in each year. The final data set included 4,312 hospitals.

Exposure

For each year, we identified hospitals as participating in a Medicare ACO if their contract began in that calendar year or a prior year. We categorized ACOs into three types: physician-led (in which hospitals participated but were not listed among the leadership group), hospital-led (in which hospitals led and physician organizations were not among the leadership group), and physician-hospital collaborations (in which both hospitals and physicians led the ACO), which were defined by Leavitt Partners based on the content of available public information on each ACO.

Outcomes

To capture the strength of relationships between each hospital and all other hospitals, we measured the total volume of patients that each hospital shared with all other hospitals (Table 1). We next created a measure that captured the strength of relationships with hospitals that were close or peripheral partners. To do so, we created a binary measure that defined a close partner as a hospital with which the focal hospital shared a large proportion of their total volume of patients (defined as greater than or equal to the seventy-fifth percentile of all patient sharing relationships, or 4.83% of each hospital's total volume). A peripheral partner was defined as a hospital with which the focal hospital shared less than 4.83% of its total shared patients (but more than zero). Finally, we summed across all close and peripheral partners to create two aggregate measures: 1) the volume of patients shared with *all* close partners and 2) the volume of patients shared with *all* peripheral partners. Because the total volume of shared patients between hospitals was highly skewed, as were the volume with close and with peripheral partners, for each measure, we used the measures' natural log as dependent variables.

Controls

We used data from several sources to control for time-varying factors that might bias estimates of the relationship between ACO participation and shared patient volume. We used measures from the AHA survey of hospital size, teaching status, system and network membership, ownership status, and whether they offered general acute care or specialty care. We also included hospitals' case mix index—a measure of the clinical complexity of patients served derived from Diagnosis-Related Groups. Finally, we included county-level demographic characteristics including income per capita, unemployment rate, percentage female, population density, percentage of population over age 65, and physicians per 1,000 residents. We included these controls because ACOs may be more likely to form in markets with an increasing supply of providers to gain bargaining power and with populations that are becoming relatively easier to coordinate, which make ACOs more appealing; changes in

these demographic characteristics may also relate to how providers share patients (Hollingsworth et al., 2015).

Analysis

To examine our first research question, we estimated a fixed-effect model, clustering standard errors by hospitals, to predict the log volume of shared patients in each year from 2010 to 2014. Independent variables included indicators for hospital ACO participation in each year, as well as calendar year, hospital and county control variables. The fixed-effects model eliminates the influence of time-invariant hospital characteristics that may bias our estimation of the relationship between ACO membership and patient sharing volume. (Wooldridge, 2015) To examine our second research question, we measured changes in (1) the log volume of shared patients that are shared with close partners and (2) the log volume of shared patients that are shared with peripheral partners by rerunning the fixed effects models for each dependent variable. To examine our third research question, we redefined ACO participation by three types of ACO structure (physician-led, hospital-led, or physician-hospital collaboration) and estimated changes in the log volume of shared patients with all other hospitals by participation in each type of ACO.

In robustness tests, we addressed six potential threats to the validity of our results. First, to address the possibility that hospitals that joined in ACO in the study period are different than hospitals that did not in observable dimensions that may bias change over time, we matched hospitals in the pre-period by hospital characteristics and volume of shared patients and repeated our fixed effects model in samples including only the set of matched case-control hospitals. Second, to address concerns that hospitals' shared patient volumes are interrelated, we repeated our models clustering standard errors by hospital referral region, geographic areas containing hospitals linked by shared referral patterns, rather than by hospital, and reran our models. Third, to address concerns that our findings on close or peripheral partners could be driven by how we defined 'close' and 'peripheral', we altered that definition by classifying partners into more categories of closeness and by defining closeness based on the shared patients with that partner *relative* to that hospital's other partners (i.e., as opposed to an absolute cutoff used in our main analysis). We then reran our models with these alternative measures. Fourth, the Physician Shared Patient Patterns data excludes hospital pairs that did not share at least 11 patients; therefore, we sought to address the possibility that missing data on the volume of shared patients for hospitals that appeared to share no patients with peripheral partners would bias our results, we reran the model predicting shared volume of peripheral partners with a value of 10 encoded for hospitals missing data on patients shared with peripheral patients. Fifth, we suspected that the pattern of results we observed may have been driven by changes in patient sharing between hospitals that join the same ACO. We therefore investigated whether volume of patients shared between hospitals that eventually joined an ACO, increased after those hospitals joined the ACO. Finally, because the association between ACO participation and close and peripheral shared patients may vary based on multi-hospital system membership, we stratified the total volume of shared patients by system relationship and reran our models to investigate the effect of same-system membership on trends in patient sharing. Full details of these analyses are available in the supplementary file.

Results

Sample Descriptive Statistics.

The final analytic sample included 4,312 non-federal, acute care hospitals. By 2014, 484 hospitals participated in a Medicare ACO, accounting for 11.2% of the sample. Hospitals participating in ACOs were larger, more likely to be not-for-profit, and more likely to be teaching hospitals than non-participants (Table 2). Hospitals that eventually joined ACOs shared a larger volume of patients with other hospitals in 2010, with an average of 8,764 total Medicare patients shared, as opposed to 4,885 for hospitals that never joined an ACO. The median hospital shared 80.9% of their patients with close partners and 19.1% with peripheral partners.

Strength of Inter-Hospital Relationships: Unadjusted Trends.

The overall strength of each hospital's relationships with all other hospitals increased over the course of the five-year study period. For hospitals that eventually joined an ACO, the mean number of Medicare patients shared with other hospitals increased by 2,281 patients or 26.0%, from 8,764 in 2010 to 11,045 patients in 2014. For hospitals that never joined an ACO, the mean number of shared patients increased by 1,109 patients or 22.7%, from 4,885 to 5,994 (Figure 1). In other words, ACO hospitals increased shared patient relationships with other hospitals more than non-ACO hospitals both in absolute terms (with total growth 205% greater than non-ACO hospitals) and in relative terms, with 15% greater relative increase from the baseline year. This greater increase was focused in close partners, in which the strength of relationships increased by 17% more among ACO hospitals than non-ACO hospitals, and not in peripheral partners, which only increased by 6% more (Figure 2).

Strength of Inter-Hospital Relationships: Adjusted Estimates.

In our fixed effects models (Figure 3), we found that ACO membership was associated with an increase in overall relationship strength of approximately 4.4% of shared patients [95% confidence interval (CI), 1.9 to 6.8]. Full regression results are available in supplementary file. When we separated partners into close and peripheral groups, ACO membership was associated with a statistically significant increase in the strength of close partner relationships, with an increase of approximately 4.6% (95% CI, 2.2 to 7.0), but was not associated with an increase in the strength of peripheral partner relationships relative to the increase among non-ACO hospitals over the same time span [estimated association was +0.8% of shared patients (95% CI, -2.5 to 4.2)].

ACO Structure.

Hospital participation in a physician-hospital collaboration ACO (i.e. one that was led by both hospitals and physicians) was significantly associated with overall strength of relationships [5.9% increase in shared patient (95% CI, 2.2 to 9.7)]. Neither hospital participation in a hospital-led ACO nor participation in a physician-led ACO, in which the hospital did not have a role in ACO leadership but agreed to participate, was associated with relationship strength [increase of 2.0% (95% CI, -0.4 to 4.5) and 3.1% (95% CI, -3.1 to 9.3), respectively].

Robustness Tests.

Our results were consistent when we used a set of matched case-control hospitals (Appendix Table 4) and patterns of statistical significance did not change based on level of clustering (Appendix Table 5). Our results were generally robust to changes in how we defined close and peripheral partners and encoded missing data (Appendix Tables 6 and 7). To our surprise, we did not observe an association between hospitals that joined the same ACO and the volume of shared patients. Our results were robust when we excluded patients shared between hospitals in the same ACO (Appendix Table 8). When we investigated the relationship between ACO participation and the strength of hospital relationships by multi-hospital system membership, we observed a somewhat larger increase in relationships among hospitals in the same system (Appendix Tables 9 and 10).

Discussion

Our study has three important findings. First, our broad analysis of all inter-hospital patient movement among Medicare FFS patients indicates that, rather than work to decrease patient leakage, hospitals participating in an ACO increased their sharing of patients with other hospitals beyond the secular trend over time. Second, increased patient sharing occurred primarily among a narrow set of partners with whom participating hospitals shared a high volume of patients—that is, strong relationships became even stronger. Finally, an ACO's ability to alter a hospital's relationships with other hospitals appeared to depend, in part, on its structure. In particular, physician-hospital collaborations were the most successful.

Literature on hospital relationships through patient referrals and other shared patient trends has demonstrated that hospital networks are not ideally structured to promote efficient and high-quality care (Bilimoria et al., 2010; Ho & Pakes, 2014; Iwashyna, Christie, Moody, Kahn, & Asch, 2009). Our study indicates that policy initiatives that change organizations' incentives may be a promising approach to encourage organizations to alter these relationships. This finding is consistent with a prior study that examined ACO effects on patient referrals: an analysis of the Alternative Quality Contract, a private sector precursor to the Medicare Shared Savings Program, showed that participating primary care providers monitored referrals, steering patients from more to less expensive specialist physicians in an effort to decrease costs (Song et al., 2011). Similar efforts to control costs, incentivized by ACO programs, may underlie our findings of hospitals willingness to increase relationships with outside organizations, but the trends observed in our analysis should be confirmed by more detailed evaluation of *why* specific patient sharing relationships change. Given the high proportion of patients that receive care outside of an ACO (Han et al., 2016), managing these relationships with other organizations may be a core competency for an ACO to meet its quality and efficiency goals. A more detailed understanding of how ACOs accomplish this goal could lead to improved organizational strategies.

Further, by incentivizing high-quality, efficient care, regardless of source, ACOs may encourage participating organizations to allocate patients to care settings best equipped to treat specific patient types. For instance, smaller community hospitals may be more likely to send highly complex patients to quaternary care centers, while these centers may be more likely to send uncomplicated patients to community hospitals where they might receive more

efficient treatment. Increasing the efficient allocation of patient by clinical need has been cited as a key strategic motivator for several ACO initiatives both within existing integrated systems and across unaffiliated hospitals(Higgins; Porter). While prior research has found that physician-led ACOs have been most effective on some measures of performance, (McWilliams, Chernew, Landon, & Schwartz, 2015) we were not surprised to find that hospital-physician ACOs had the largest impact on hospital relationships because of their ability to influence hospital behavior both directly and through physician's discretion over referrals. Our finding of a larger effect among hospitals in the same multi-hospital system indicates that formally aligned hospitals may face fewer barriers, and more incentives, towards altering shared patient practices with these hospitals.

However, we did not find that hospitals increased their patient sharing with other hospitals that joined the same ACO. This lack of relationship may be driven by the relatively small number of hospital pairs that participated in the same ACO (comprising only 1.5% of hospital pairs that shared patients) or because hospitals that joined the same ACO in the first three years of the ACO program had already worked to improve patient sharing practices, leaving limited room for improvement. As more and more hospitals participate in ACOs, and as individual ACO efforts continue to grow, it will be important to monitor how participation in the same ACO alters inter-hospital patient sharing within the ACO.

By further strengthening relationships with hospitals that were already close partners, ACO participation may facilitate care coordination built on established inter-organizational relationships (Hoffer Gittell, 2002) and robust inter-organizational routines (Levitt & March, 1988). In consequence, while the increase in shared patients we observe may indicate that ACO hospitals do not limit leakage from their hospitals, the increased focus in close partner hospitals may indicate that they do seek to limit leakage to non-trusted partners. In other words, while increased patient sharing between hospitals may reflect lower levels of continuity of care from a single organization, it may represent higher levels of care continuity defined as “the degree to which a series of discrete healthcare events is experienced as coherent and connected and consistent with the patient's medical needs and personal context (Haggerty et al., 2003).” Again, more focused analysis—perhaps including interviews of ACO leaders and patients undergoing hospital transitions—could identify the specific mechanisms leading to our findings and their effect on the quality of care.

Our study must be considered in the context of several limitations. First, our strategy for measuring relationships between hospitals using patient sharing between hospitals does not differentiate between an intentional hospital-to-hospital transfer, a referral for a procedure at a later date, readmission to a hospital other than the initial site of care, or simple happenstance through which patients receive treatment at multiple facilities. Our proposed mechanism through which ACOs impact patient sharing patterns are most directly relevant to intentional transfers and referrals. Nevertheless, it is possible that observed changes in shared patients relate to changes in readmission or other unintentional patient movement and are thereby driven by factors other than intentional changes in where hospitals send their patients. For the same reason, however, our finding of an association between ACO participation and hospital patient-sharing networks likely underestimates the extent of change in the strategic relationship between hospitals by underestimating the change in

discretionary shared patients due to inclusion of many patient movements that are outside an organization's influence. Second, we cannot determine whether increased patient sharing results in patients receiving care in a more appropriate setting. Although increases in patient sharing following hospital ACO participation may relate to care needs, they could also be motivated by financial incentives or other relevant factors. It may be that as ACOs encourage hospitals to consider external partners, these hospitals simply (and perhaps myopically) prefer trusted partners with whom they have prior experience, even when inter-organizational routines are no better and the outside hospital is not an appropriate site of care (Rogan & Sorenson, 2014). Third, while we used a robust panel design to measure ACO effects, parallel trends may underlie the observed relationships, limiting our ability to make causal claims. Finally, our data focus on just one type of relationship—the inter-hospital network of Medicare shared patients. For instance, given the data available we were not able to investigate changes in the hospital-physician network of shared patients because we did not have access to robust data on hospital-physician employment, a potential confounder in that analysis. Further research is necessary to uncover the relationship between ACO participation and other types of networks (e.g., inter-physician networks, networks of patients with other types of insurance) (Hollingsworth et al., 2015; Landon et al., 2012).

Conclusion

In this study examining a broad population of patients, we found that hospital participation in ACOs was associated with stronger relationships with outside hospitals rather than limited 'leakage', and in particular stronger relationships with close partner hospitals. This was especially true for hospitals that participated in hospital-physician led ACOs. While our findings do not directly identify the effects of the observed changes, the deepening of relationship we observed may facilitate efficient allocation of patients by clinical needs and organizational capability, and may increase inter-organizational coordination as routines are more deeply developed and supported through experience. These findings indicate one important mechanism through which ACO policies may be influencing patient care. Policymakers, researchers and organizational leaders should monitor the extent to which ACO participation and other quality-based programs lead to changes in relationships between provider organizations as expressed through patient travel patterns and who these changes benefit and harm. The trends we identified could be most immediately advanced by efforts that assess which patient types are most likely to move between hospitals and if the outcomes for patients moving between close partners are better than those moving between peripheral ones.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding Support: Dr. Hollingsworth received support for this work from the Agency for Healthcare Research and Quality 1R01HS024525 01A1 and 1R01HS024728 01

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Figure 1. Trend in Relationship Strength by ACO Membership

Data on shared patients with was available for 484 hospitals each year that eventually joined ACOs and 3,828 hospitals that never joined ACOs.

Figure 2. Trend in Relationship Strength by ACO Membership and Partner Type

Data on shared patients with close partners was available for 484 hospitals each year that eventually joined ACOs and 3,828 hospitals that never joined ACOs. Data on shared patients with peripheral partners was available for between 473 and 478 hospitals each year that eventually joined ACOs and 3,616–3,643 hospitals that never joined ACOs.

Figure 3. Forest Plot of Fixed Effects Models Predicting Relationship Strength (Medicare Patients Shared by Hospitals) by ACO Participation

n=21,560 hospital-year observations in all multivariable models, except for peripheral partners, for which 20,542 hospital-year observations were available. Confidence intervals defined using standard errors clustered by hospital (analysis repeated using hospital-referral region-clustered standard errors produced consistent results [Appendix Table 5]).

Table 1.

Description of Each Construct and Associated Measure.

Construct	Measure	Description
<i>Primary Outcome Variable</i>		
Overall Relationship Strength	Log Volume of Shared Patients	The logarithm of the number of shared patients between the focal hospital and all other hospitals. An increase in the logarithm is approximately equivalent to a percentage increase in the volume of shared patients.
<i>Partner Closeness Stratification Variables</i>		
Close Partner: Large Proportion of All Shared Patients	Binary indicator for high importance partners used to categorize hospitals.	For each hospital, close partners are those with which the hospital shares a proportion of their total shared patients greater than the 75 th percentile of all shared patient relationships across the network.
Peripheral Partner: Small or Moderate Proportion of All Shared Patients	Binary indicator for low importance partners used to categorize hospitals.	For each hospital, close partners are those with which the hospital shares a proportion of their total shared patients less than the 75 th percentile of all shared patient relationships across the network. We used this measure to categorize hospitals into close or peripheral partner groups.
<i>Secondary Outcomes: Stratified by Partner Type</i>		
Relationship Strength with Close Partners	Log volume of patients shared with <i>all</i> close partners.	The logarithm of the number of shared patients between the focal hospital and all close partners. An increase in the logarithm is approximately equivalent to a percentage increase in the volume of shared patients with close partners.
Relationship Strength with Peripheral Partners	Log volume of patients shared with <i>all</i> peripheral partners.	The logarithm of the number of shared patients between the focal hospital and all peripheral partners. An increase in the logarithm is approximately equivalent to a percentage increase in the volume of shared patients with peripheral partners.

Table 2.**Hospital Characteristics in 2010**

	Never in ACO (n=3,828)		Eventually in ACO (n=484)		p-value
	Mean	SD	Mean	SD	
Hospital Patient Sharing Volume					
Relationship Strength with All Other Hospitals (Number Shared Patients)	4,885	6,659	8,764	10,123	<0.0001
Relationship Strength with Close Partners (Number Shared Patients)	3,532	4,025	5,680	4,972	<0.0001
Relationship Strength with Peripheral Partners (Number Shared Patients)	1,353	3,447	3,085	6,306	<0.0001
Hospital Characteristics					
Major Teaching Hospital	5%	22%	15%	36%	<0.0001
Minor Teaching Hospital	11%	31%	19%	39%	<0.0001
Small Hospital (<100 Beds)	52%	50%	27%	44%	<0.0001
Medium Hospital (100–399 Beds)	39%	49%	52%	50%	<0.0001
Large Hospital (400+ Beds)	9%	28%	21%	41%	<0.0001
Not For Profit	57%	49%	84%	36%	<0.0001
For Profit	18%	38%	7%	26%	<0.0001
Government	25%	43%	8%	28%	<0.0001
System Member	53%	50%	77%	42%	<0.0001
Network Member	30%	46%	45%	50%	<0.0001
General Acute Care Hospital	97%	17%	99%	8%	0.0037
Market Share	0.13	0.17	0.21	0.18	<0.0001
Market Concentration (HHI)	0.20	0.13	0.20	0.14	0.72
County-Level Demographics					
Income per Capita	36,541	9,014	41,044	11,369	<0.0001
Unemployment Rate	9.3%	2.9%	9.2%	2.2%	0.25
PCPs per 1,000 persons	0.67	0.31	0.79	0.36	<0.0001
Physicians per 1,000 persons	2.00	1.92	3.00	2.54	<0.0001
Percentage Female	49%	3.3%	49%	3.3%	0.47
Population Density per Mile	6.8	26.2	19.4	55.0	<0.0001
Percentage Over 65	14.8%	4.1%	13.1%	3.3%	<0.0001
Total Case Mix	1.48	0.26	1.55	0.24	<0.0001

Close Partner defined as >4.5% of patients shared by hospital; Peripheral Partner defined as <4.5% of patients shared by hospital