

Identifying Natural Alignments Between Ambulatory Surgery Centers and Local Health Systems

Building Broader Communities of Surgical Care

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Objective: To develop and compare methods for identifying natural alignments between ambulatory surgery centers (ASCs) and hospitals that anchor local health systems.

Measures: Using all-payer data from Florida's State Ambulatory Surgery and Inpatient Databases (2005–2009), we developed 3 methods for identifying alignments between ASCs and hospitals. The first, a geographic proximity approach, used spatial data to assign an ASC to its nearest hospital neighbor. The second, a predominant affiliation approach, assigned an ASC to the hospital with which it shared a plurality of surgeons. The third, a network community approach, linked an ASC with a larger group of hospitals held together by naturally occurring physician networks. We compared each method in terms of its ability to capture meaningful and stable affiliations and its administrative simplicity.

Results: Although the proximity approach was simplest to implement and produced the most durable alignments, ASC surgeon's loyalty to the assigned hospital was low with this method. The predominant affiliation and network community approaches performed better and nearly equivalently on these metrics, capturing more meaningful affiliations between ASCs and hospitals. However, the latter's alignments were least durable, and it was complex to administer.

Conclusions: We describe 3 methods for identifying natural alignments between ASCs and hospitals, each with strengths and weaknesses. These methods will help health system managers identify ASCs with which to partner. Moreover, health services

researchers and policy analysts can use them to study broader communities of surgical care.

Key Words: ambulatory surgery centers, accountable care organizations, network analysis

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Ambulatory surgery centers (ASCs) pose a dilemma for policymakers and health system managers. On the one hand, these noninstitutional providers allow for the delivery of surgical services at lower cost than traditional hospital settings.^{1,2} In contrast, almost all ASCs are owned by the surgeons who staff them.³ Prior research suggests that because ownership allows surgeons to capture both physician and facility fees, increased payments can alter treatment thresholds, leading to increases in discretionary surgery.⁴ This may result in higher overall spending and diminished marginal benefit to patients.

One way to take advantage of the cost-efficiency gains associated with ASCs, while limiting the potential for unnecessary procedures, is to bring them under the purview of health systems that have adopted global payment models [eg, Medicare's Accountable Care Organization (ACO) program]. To do this, health system managers must be able to identify ASCs with which their institutions have some sort of relationship. Leaders could then create formal partnerships with these ASCs, altering the current incentive structure. Although prior research has developed methods for defining groups of primary care physicians and hospitals most ready to become accountable for a patient population,^{5–7} by focusing on physicians and hospitals these methods overlook the place of ASCs in the ecology of surgical care delivery.

Therefore, we used data from Florida to develop and compare 3 approaches for aligning ASCs with hospitals. We chose to focus on hospitals because these organizations serve formally and informally as anchors for outpatient clinics and other facilities that constitute local health systems. The first approach, a *geographic proximity* method, uses spatial data to identify an ASC's nearest hospital. The second approach, a *predominant affiliation* method, relies on a surgeon plurality algorithm to identify an anchor hospital for each ASC. The third approach, a *network community* method, leverages network analysis to build on naturally occurring affiliations

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between the 2 organizational forms, allowing ASCs to be assigned to multiple hospitals.

Our methods may prove useful to leaders of health systems who seek to reduce costs and create broader, more integrated communities of care by partnering with ASCs. Although maximizing the value of partnerships ultimately requires that leaders agree upon a model attractive from the perspective of both a health system and an ASC, formal relationships that build on preexisting natural affiliations are likely to reduce costs and offer added convenience for patients and physicians.⁸ In addition, leaders of ASCs may also benefit from the availability of algorithms that help them identify and cultivate relationships with key local health systems. Although global payment programs like ACOs do not prevent patients from seeing external providers, referrals from primary care physicians are influential over patient's choices about where to go for specialty treatments. To the extent that primary care physicians direct patients to surgical specialists within their own global payment program, ASCs that establish formal relationships with local health systems by joining such programs should benefit from more steady streams of patient referrals. Finally, our methods may also be valuable for health services researchers and policy analysts who seek to study broader communities of interdependent surgical care organizations.

METHODS

Data Source and Study Population

For our study, we used the Florida files of the Healthcare Cost and Utilization Project's (HCUP's) State Ambulatory Surgery (SASD)⁹ and Inpatient Databases (SID).¹⁰ These data capture the universe of surgical procedures performed at outpatient surgery centers and in acute care, nonfederal hospitals; their completeness has been validated through alternative sources of comparative data.¹¹ We concentrated on Florida for 2 reasons. First, Florida's Agency for Health Care Administration, which contributes its data to HCUP, collects provider information that allowed us to follow individual surgeons over time. Second, Florida's outpatient records include discharges from both hospitals and freestanding ASCs.

We focused our attention on hospitals and ASCs active in the state between January 1, 2005 and December 31, 2009. For each surgical discharge, we used unique provider identifiers in the SASD and SID to determine the operating surgeon and the facility at which the procedure was performed. Through a binary indicator included in the SASD, we were able to distinguish facility type—freestanding ASC versus hospital.

Methods for Aligning ASCs With Hospitals That Anchor Local Health Systems

Our first strategy leveraged spatial data to align ASCs with a single-anchor hospital that was most proximate geographically. After identifying the latitude and longitude of the street address for each hospital and ASC, we calculated geographic proximity as the straight-line distance between pairs of organizations. We then adjusted the resulting values

for potential bias due to the curvature of the Earth's surface. Unlike our other approaches, this method did not require information on physician practice patterns. The social science literature suggests strong positive correlations between proximity, relationship formation, and information exchange.¹² As such, alignment based on proximity may help reduce costs and increase coordination by facilitating communication among ASC and hospital leadership.

The second strategy that we developed also matched ASCs to a single-anchor hospital, but it did so by attempting to mirror affiliations between the 2 organizational forms that are created when surgeons have activity at both inpatient and outpatient settings. Specifically, we used a 2-stage procedure to define simple networks among ASCs and hospitals. In the first stage, we made use of unique provider identifiers to generate a bipartite network in which ties connected surgeons to hospitals and ASCs.^{13–15} To remove noise and ensure that our approach captured meaningful affiliations, we limited our sample to surgeons who performed at least 10 procedures at a hospital or ASC in a calendar year.¹⁶ This threshold corresponded to roughly 15% of the average number of procedures performed by each surgeon per facility, and it was stable across the study interval. After introducing the threshold, our sample consisted of, on an average, 16,245 (SD, 2979) hospital-only surgeons, 1233 (SD, 103) ASC-only surgeons, and 3239 (SD, 193) who were affiliated with at least 1 hospital and 1 ASC. These 3 groups performed, on an average, 2,269,874 (SD, 77,956), 439,113 (SD, 25,065), and 1,707,319 (SD, 222,121) procedures, respectively, within each calendar year. Our substantive findings remained the same if we eliminated the threshold and considered all ties regardless of their strength.

In the second stage, we created a unipartite projection of the bipartite network such that hospitals and ASCs were directly connected by ties representing shared surgeons.¹⁷ For each ASC, we labeled the hospital with which it shared the plurality of its surgeons as its anchor. In the few cases where none of the surgeons with ties to a particular ASC performed at least 10 procedures at a hospital, we labeled the anchor as the hospital where most surgeons affiliated with the ASC performed at least 1 surgery.

Our third strategy also sought to align ASCs with hospitals by building on existing affiliations that were formed by surgeons who worked in both settings. Rather than aligning each ASC with a single-anchor hospital, our network community approach kept all ties among ASCs and hospitals, and linked each ASC to a community of hospitals (and other ASCs). By retaining more data on connections among facilities, this method provides a more realistic, though also more complex, depiction of the relations between outpatient and inpatient surgical care organizations.

We began with a highly connected network of all ASCs and hospitals in Florida, for each study year. Following prior work on patient-sharing networks,^{7,18} we then partitioned the network into meaningful subgroups using an edge-betweenness community detection algorithm.^{19,20} This algorithm identifies communities as sets of ASCs and hospitals that are densely connected to one another but have relatively few connections to other parts of the network. To

facilitate comparisons with our predominant affiliation method, we excluded ties among organizations of the same form (eg, hospital-hospital and ASC-ASC). By excluding ties among organizations of the same form, we ensure that the community assignments are driven by the pattern of affiliations between ASCs and hospitals, which is the focus of our study. As with the predominant affiliation method, we did not weight ties by the strength of their connection. Analyses that weighted ties by the number of shared physicians, however, yielded similar results.

Statistical Analysis

After aligning all ASCs with hospitals, we performed several tests to evaluate the effectiveness of each approach at identifying natural alignments. As our initial analytic step, we assessed the degree of surgeon loyalty to the anchor hospital(s) for each of the 3 methods.⁵ Our measure of loyalty is defined as the proportion of surgeons at an ASC who had a tie to (ie, performed 10 or more procedures at) the assigned anchor hospital. We then examined the stability of our different alignment approaches over time (see the Appendix for methodological details). Together, these 2 evaluation metrics help illustrate how the proposed approaches differ in their ability to identify affiliations that may serve as useful foundations for negotiating formal partnerships that govern payments. Moreover, by building on established relationships with a high degree of loyalty and stability, leaders of local health systems and ASCs may reduce administrative costs by minimizing the need for extensive monitoring and frequent renegotiation.^{8,21} Finally, we examined the degree to which aligning ASCs with hospitals using the different methods could potentially integrate outpatient surgical procedures and their associated charges from across the State of Florida into local health systems.

We performed all analyses using the *R* statistical environment, version 3.0.²² To account for nonindependent observations of the same ASCs over time and across methods, we perform tests of statistical significance using repeated measures analysis of variance. For network visualizations and computations, we used version 0.6.5 of the *igraph* software package.²³ We visualized the networks using a spring-embedded layout algorithm.²⁴ The University of Michigan Health Sciences Institutional Review Board has determined that this study is exempt from oversight.

RESULTS

Figure 1 illustrates the hospital alignments for a single Florida ASC in 2008 across each of the 3 methods. Each panel displays 1 “alignment group,” which is an independent set of aligned ASCs and an anchor hospital(s). By design, the geographic proximity and predominant affiliation approaches are similar in that they both result in a hub and spoke network structure anchored by a single hospital that serves as an administrative core. However, the 2 methods differ with respect to the size and member composition of the alignments they produce. The network community approach reveals a substantially more complex and decentralized alignment between the example ASC and a family of hospitals. In contrast to the prior 2 approaches, there is no

administrative core. However, the method does reveal substantial interdependencies among groups of surgical care organizations that are lost in the process of assigning ASCs to a single-anchor hospital.

Figure 2 illustrates surgeon loyalty, stratified by the 3 assignment methods. Overall, the geographic proximity method captured a significantly lower proportion of ties between surgeons at ASCs and the anchor. For example, the difference in means between alignments based on the predominant affiliation method and those defined geographically ranged from a low of 0.19 (SE, 0.03) in 2005 ($P < 0.001$) to a high of 0.22 (SE, 0.02) in 2008 ($P < 0.001$), both favoring the predominant affiliation approach. The more complex network community method, which allowed ASCs to be connected to multiple anchor hospitals, performed only marginally better than the predominant affiliation method. For instance, networks defined using the network community method captured, on an average, a low of 0.04 (SE, 0.03) more surgeons with ties to anchor(s) in 2006 ($P = 0.034$) and a high of 0.08 (SE, 0.02) more in 2008 ($P < 0.001$) than the predominant affiliation approach.

Table 1 displays the natural affiliations among ASCs and hospitals that are created by physicians who see patients in both types of organizations. Once again, we use a 10-discharge threshold, although the results are qualitatively similar if we eliminate this requirement. Overall, ASCs are connected to relatively few hospitals, ranging from a mean of 4.2 (SD, 3.6) in 2005 to 4.9 (SD, 4.2) in 2008. The modal ASC is connected to only 1 hospital across all study years. The average Florida surgeon works at 0.3 (SD, 0.6) ASCs per year. Put differently, insofar as surgeons practice at ASCs, most limit their activity to 1 or 2 facilities, although a handful are connected to more (up to 6). Although surgeons tend to have more ties to hospitals than ASCs, the modal surgeon has 1 hospital tie across years (mean, 1.3; SD, 0.9), indicating that most surgeons limit their hospital activity to a small number of facilities.

Table 2 evaluates the stability of each alignment method over time. As might be expected, the geographic proximity approach creates extremely stable alignment groups that are subject to change only if an anchor hospital closes or a new, more proximate one is founded. The predominant affiliation approach also exhibits notable stability. Using this method, the total number of alignment groups remained largely consistent, ranging from a low of 127 in 2007 to a high of 142 in 2009. This level of stability is noteworthy given the relatively high annual entry and exit rates among ASCs. Moreover, relatively few ASCs changed alignment groups from one time period to the next. In 2008, for instance, the year with the most membership changes, only 19 ASCs (roughly 5%) swapped groups. The alignment groups produced by the network community method were least stable, with anywhere from 12 to 73 ASCs changing membership in consecutive years.

Table 3 examines how well the 3 methods are able to align ASC activities with hospitals across Florida. Because the geographic proximity approach aligns all ASCs with an anchor hospital—regardless of whether there are any natural affiliations between the facilities—this approach has the

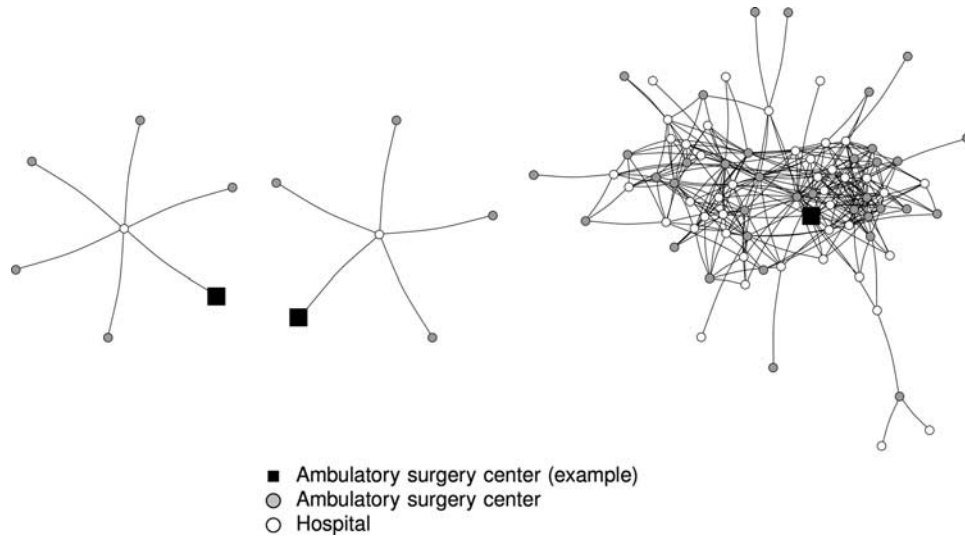


FIGURE 1. Three methods for aligning ambulatory surgery centers with hospitals.

potential to bring 100% of surgical discharges and charges originating from ASCs under the umbrella of a health system. The predominant affiliation and network community methods also perform well, and are able to capture well over 90% of all surgical discharges and charges originating from

ASCs. Regardless of the method used, aligning ASCs with hospitals has the potential to expand the reach of health reform efforts. Consider again the year 2008, during which there were a total of 4,626,882 surgical discharges statewide. Only 68% were from inpatient facilities. If global payment

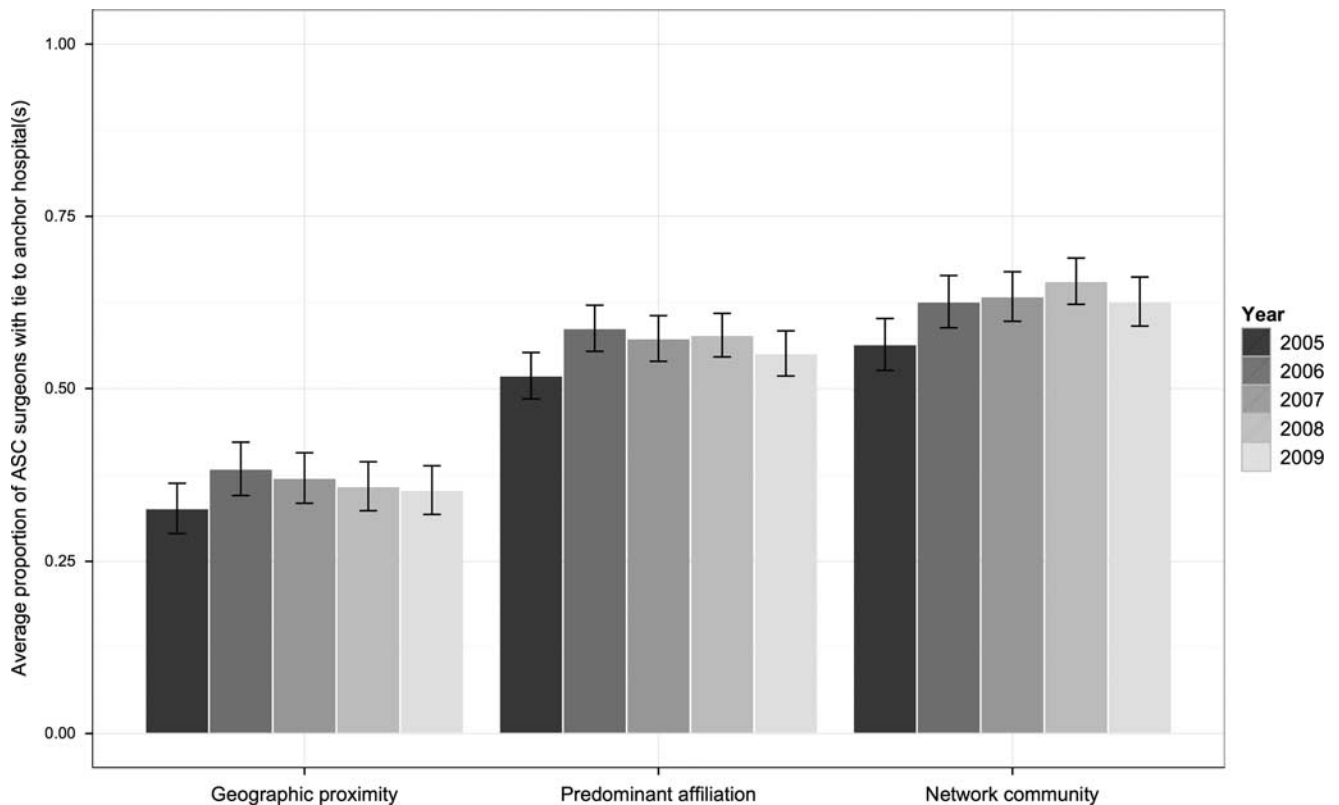


FIGURE 2. Ambulatory surgery center surgeon’s loyalty to anchor hospitals, by method.

TABLE 1. Indicators of Loyalty Among ASCs, Hospitals, and Surgeons*

	2005	2006	2007	2008	2009
Average ties to ASCs per surgeon	0.2 (0.5)	0.3 (0.5)	0.3 (0.6)	0.3 (0.6)	0.3 (0.6)
Average ties to hospitals per surgeon	1.2 (0.8)	1.3 (0.9)	1.3 (0.8)	1.3 (0.9)	1.3 (0.9)
Average ties to hospitals per ASC	4.2 (3.6)	4.7 (3.9)	4.8 (4.1)	4.9 (4.2)	4.7 (3.9)

*SDs in parentheses.
ASC indicates ambulatory surgery center.

models like ACOs exclude ASCs, roughly 32% of operations are exempt from oversight.

DISCUSSION

We have developed and compared 3 methods for identifying alignments between ASCs and hospitals. Our focus on hospitals is motivated by the observation that these organizations typically anchor larger health systems. Each of the 3 approaches has strengths and weaknesses, which vary most importantly with respect to the nature of their simplifying assumptions and their degree of administrative and implementation simplicity.

The geographic proximity approach requires only minimal data and may allow leaders charged with implementing global payment models like ACOs to quickly identify potential ASCs with which to form partnerships. Geographic proximity-based alignment groups are also extremely stable over time, which further adds to the attractiveness of this approach from an administrative standpoint. However, we also found that proximity between ASCs and hospitals is not necessarily a good predictor of shared physicians between the 2 organizational forms.

The predominant affiliation approach, like the geographic proximity method, also aligns ASCs to a single-anchor hospital in an effort to maintain administrative simplicity. Although the alignment groups produced by the

predominant affiliation method are slightly less stable over time, the approach is attractive because it builds on naturally occurring affiliations between ASCs and hospitals and therefore ensures that partnering organizations have overlapping personnel.

Finally, the network community method offers a substantially more realistic portrayal of the complex web of relationships among ASCs and hospitals by retaining structural data that is omitted from the other 2 approaches. However, the alignment groups produced by this method are less stable over time. Moreover, the approach also results in larger clusters of organizations, which may prove challenging for administrators to coordinate and manage.

Driven by multiple factors, the popularity of ASCs for outpatient surgery is growing. Although these facilities offer many advantages over hospital-based surgical care, concerns have been raised regarding the high prevalence of ownership among the physicians who staff them. As owners are entitled to collect a share of the facility's profits from referrals in addition to their professional fees, desire to see their investment succeed may lead owners to lower their treatment thresholds.^{25,26} Incentive systems like this may encourage unnecessary procedures, thereby limiting the effectiveness of larger efforts at health care reform that seek to eliminate low value spending and services.

One way to take advantage of the benefits of ASCs, while mitigating the potential for overuse, is to incorporate ASCs into the accountable care model, whereby physicians are rewarded for improving care quality and containing costs for a patient population.^{27,28} Yet, while established methodologies for defining ACOs focus on networks of primary care physicians and hospitals,^{5-7,27} they overlook the important place of freestanding ASCs in the ecology of surgical care delivery and consequently may miss over 40% of all annual US outpatient surgery visits.²⁹ Thus, to increase the integration of ASCs into larger communities of care, novel methodologies are necessary to help managers of local health systems identify ASCs with which they have preexisting informal relationships. These informal relationships may in turn serve as an entry point for negotiations about more formal agreements.

Our analysis should also be valuable for leaders of ASCs. Although global payment models like ACOs do not restrict where members of their assigned patient populations can receive care, patient's choices about specialty treatments are heavily influenced by referrals from their primary care physicians. To the extent that primary care physicians see advantages to referring patients to facilities within the ACO

TABLE 2. Comparison of Alignment Group Composition and Membership Stability Over Time, by Method

	2005	2006	2007	2008	2009
Geographic proximity					
ASC alignment changes	—	0	3	0	0
ASC isolates	0	0	0	0	0
Alignment groups	128	133	134	147	145
Predominant affiliation					
ASC alignment changes	—	18	13	19	20
ASC isolates	9	11	12	14	11
Alignment groups	130	130	127	140	142
Network community					
ASC alignment changes	—	50	29	12	73
ASC isolates	55	50	49	38	45
Alignment groups	17	13	15	13	17
Overall					
ASC entries (eg, foundings)	—	24	24	25	18
ASC exits (eg, bankruptcies)	—	15	10	14	10
ASCs	321	330	344	355	363
Hospitals	238	245	250	255	249

ASC indicates ambulatory surgery center.

TABLE 3. Surgical Charges and Discharges at Florida ASCs Captured by Each Alignment Method

	Total	Geographic Proximity	Predominant Affiliation	Network Community
Discharges				
2005	1,289,676	1,289,676 (100%)	1,262,027 (98%)	1,168,167 (91%)
2006	1,371,696	1,371,696 (100%)	1,345,638 (98%)	1,268,155 (92%)
2007	1,444,973	1,444,973 (100%)	1,412,993 (98%)	1,328,164 (92%)
2008	1,473,984	1,473,984 (100%)	1,442,406 (98%)	1,372,436 (93%)
2009	1,476,941	1,476,941 (100%)	1,450,979 (98%)	1,341,545 (91%)
Charges				
2005	\$3,559,376,153	\$3,559,376,153 (100%)	\$3,504,756,030 (98%)	\$3,309,866,935 (93%)
2006	\$3,916,210,405	\$3,916,210,405 (100%)	\$3,861,925,077 (99%)	\$3,668,865,044 (94%)
2007	\$4,449,969,869	\$4,449,969,869 (100%)	\$4,337,663,693 (97%)	\$4,160,119,555 (93%)
2008	\$4,943,531,496	\$4,943,531,496 (100%)	\$4,879,953,970 (99%)	\$4,595,759,594 (93%)
2009	\$5,085,699,640	\$5,085,699,640 (100%)	\$5,006,186,680 (98%)	\$4,662,282,019 (92%)

ASC indicates ambulatory surgery center.

to which they belong, ASCs may secure steady streams of patients by partnering with health systems with which they have strong preexisting natural affiliations.

Finally, our methods may also be valuable for health services researchers and policy analysts who seek to evaluate the performance of newly developing ACOs. For example, established policies for defining ACOs allow groups of primary care physicians, hospitals, and other providers to volunteer to be held accountable for a patient population.^{5,6} Some, however, question whether policies that allow ACOs to self-identify may hinder broader care coordination.^{7,27} Our approaches could be useful for addressing these concerns by determining whether overlap between the participating groups and broader, interdependent communities of surgical care organizations influence ACO effectiveness. Moreover, the methods we propose could be used to empirically examine questions about the anticompetitive effects of ACOs and similar payment programs.^{30,31} Although further investigation is necessary, we suspect larger groups of aligned ASCs and hospitals that score high on our measure of loyalty may be the most at risk of suppressing competition, especially in places where relatively few independent surgical care organizations remain in the local market after integration. Such concentration of surgical care may make it challenging for entrants to remain independent while still being able to access referrals.

The findings of our study must be considered in the context of several limitations. First, despite the comprehensiveness of the SASD and SID, neither database reports discharges from Federal hospitals. Although the number of procedures performed in these facilities represents just a fraction of the total, such omissions could bias our measures and alter the effectiveness of our approaches for certain communities. Second, the relevance of our methods may be limited for ASCs that specialize in particular areas (eg, ophthalmology) where few procedures take place in the hospital and consequently, surgeons lack natural affiliations with inpatient facilities. Third, we evaluated our methods using data from Florida, a state that places few restrictions on competition in health care and that has historically led the nation in annual surgical discharges.⁹ Our findings may not generalize to other states. Finally, as a result of data constraints, we were only able to evaluate the relevance of our

approach for containing health care expenditures by using charges, not actual costs.^{32,33} As noted by others, the relationship between charges and costs is often weak and, therefore, our analyses in this area should be viewed simply as suggestive.

Limitations notwithstanding, our work has notable implications for health care policy and clinical practice. The availability of effective methods for aligning ASCs with global payment models like ACOs should help facilitate communication among providers within relevant communities and, in so doing, enhance patient outcomes.

CONCLUSIONS

In summary, we have developed and compared 3 methods for aligning ASCs with local health systems. Our analysis should prove attractive to leaders of ACOs who seek to build broader, more integrated communities of care by better monitoring of the surgical services provided by their physicians and ultimately the health of their assigned patient populations.

METHODOLOGICAL APPENDIX

Although it is straightforward to identify when an ASC moves from being an isolate to an alignment group member or, alternatively, from being an alignment group member to an isolate, tracking movements across groups is more challenging. The identities of alignment groups change and evolve over time as existing members leave and new ones join.³⁴ We link alignment groups across years by examining the similarity of their member organizations from time t to $t+1$ and selecting pairs that maximize similarity across the 2 periods. We define similarity as:

$$S_A(t) = \frac{|A(t) \cap A(t+1)|}{|A(t) \cup A(t+1)|},$$

where $A(t)$ is the set of organizations in alignment group A at time t and $A(t+1)$ is the set of organizations in network A at time $t+1$. Groups with a maximum similarity of <0.3 are considered dissolved. After linking alignment groups across periods, we can easily track the changing membership of particular ASCs.

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