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Electronic Connectivity Among US Hospitals Treating Shared Patients

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Background: Increasing electronic health information exchange (HIE) between provider organizations is a top policy priority that has been pursued by establishing varied types of networks.

Objectives: To measure electronic connectivity enabled by these networks, including community, electronic health record vendor, and national HIE networks, across US hospitals weighted by the volume of shared patients and identify characteristics that predict connectivity.

Research Design: Cross-sectional analysis of 1721 hospitals comprising 16,344 hospital pairs and 6,492,232 shared patients from 2018 CareSet Labs HOP data and national hospital surveys.

Subjects: Pairs of US acute care hospitals that delivered care to 11 or more of the same fee-for-service Medicare beneficiaries in 2018.

Measures: Whether a patient was treated by a pair of hospitals connected through participation in the same HIE network ("connected hospitals") or not connected because the hospitals participated in different networks, only 1 participated, or both did not participate.

Results: Sixty-four percent of shared patients were treated by connected hospitals. Of the remaining shared patients, 14% were treated by hospital pairs that participated in different HIE networks, 21% by pairs in which only 1 hospital participated in an HIE network, and 2% by pairs in which neither participated. Patients treated by pairs with at least 1 for-profit hospital, and by pairs located in competitive markets, were less likely to be treated by connected hospitals.

Conclusions: While the majority of shared patients received care from connected hospitals, remaining gaps could be filled by connecting HIE networks to each other and by incentivizing certain types of hospitals that may not participate because of competitive concerns.

Key Words: hospitals, health information exchange, interoperability, care fragmentation

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Our fragmented care delivery system creates the need for provider organizations to share patient data.[1] The national health information technology (health IT) strategy to enable information sharing centers on investments in electronic health records (EHRs) that can be used to engage in electronic health information exchange (HIE).[2–4] In concept, HIE should improve access to patient information across provider organizations and disproportionately benefit individuals who receive care from multiple provider organizations.[5,6] However, to enable their EHR to share information, provider organizations must participate in networks that provide a governance framework and engage other organizations to share their information.[7]

Over the past decade, HIE networks have developed unevenly across the country, with hundreds of different networks that connect different sets of provider organizations—some focus on a given region, others focus on customers of a given EHR vendor, and still others focus on a care setting (e.g., emergency departments).[8,9] As a result, provider organizations face a complex array of options and must decide in which network(s) to participate. Prior work reveals that hospitals on average participated in three networks, suggesting that no single network allows them to connect to all the organizations with which they may routinely share patients.[10–13] For example, Epic Systems (Epic) has created a network that allows hospitals on Epic to engage in HIE with other hospitals on Epic (one of the vendor HIE networks).[14] Still, many care transitions occur between Epic and non-Epic provider organizations. Newer national HIE networks have sought to create vendor-agnostic options but still largely rely on EHR vendors to enable connectivity.[15,16] Hospitals also choose to join community HIE networks that are generally vendor-agnostic and established in some (but not all) regions.[9] These HIE networks often serve a defined geographic area but may not match where patients travel for their health care. In addition, some states have multiple community networks in overlapping geographic regions.[9]

While national statistics suggest that ~70% of hospitals participate in an HIE network(s) in order to share patient data

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electronically, we do not know the extent to which this has resulted in connectivity that mirrors where patients receive health care including how often they receive care from hospitals on the same HIE network.[13] Therefore, we created the first national measures of electronic connectivity between pairs of hospitals (ie, Hospital A can/cannot engage in HIE with Hospital B because they are/are not part of the same HIE network) and weight these measures based on the volume of Medicare beneficiaries shared by each pair (ie, the same patient received care from both hospitals in the calendar year). We then are able to identify the characteristics that predict when a patient receives care from two hospitals that are connected or not. Our measures significantly advance the approach to national interoperability measurement and offer clear guidance on where to focus efforts to increase HIE in ways that benefit the largest number of patients.

METHODS

Data Sources

Our study relied on 4 sources of data. We used the American Hospital Association Annual Survey, a near census of US hospitals, to identify hospitals and measure characteristics that we hypothesized, based on literature, would be associated with whether or not they are connected.[17] Examples include system size, ownership (eg, for-profit, not-for-profit), participation in a larger multihospital system, and market competition in each hospital's referral region. We then used data from the AHA IT Supplement Survey and from Definitive Healthcare (formerly HIMSS Logic Data) on the HIE network(s) in which each hospital participates. The AHA IT Supplement has been administered annually since 2008 and captures information on hospitals' participation in community HIE networks (referred to as local, regional or community health information organizations) and a subset of named national HIE networks. Similarly, beginning in 2014 and updated annually, Definitive Healthcare interviewed hospital CIOs to ask them about varied dimensions of health IT infrastructure, including participation in named community HIE networks and vendor HIE networks (Appendix Table 1, Supplemental Digital Content 1, http://links.lww.com/MLR/C507 for a list of networks). Our final source of data was the "HOP" Dataset, which CareSet System's derives from Medicare Fee-For-Service claims. It includes the volume of Medicare beneficiaries shared between providers. Each observation is a pair of provider organizations represented by organizational National Provider Identifiers (NPIs), and the volume of shared Medicare beneficiaries treated by both organizations. CareSet defines a shared patient as one first seen by one organization and then seen by a second organization during the same calendar year.[18] The data is derived from the hospital NPI on the claim, which includes inpatient and outpatient (eg, ED) services delivered by/at the hospital. We used 2018 data for all data sources since it was the most recent available at the start of our study.

Sample Construction and Network Definitions

Our study sample is comprised of pairs of US nonfederal acute care hospitals that shared in the care of at least 11 patients in 2018 (pairs that share 10 or fewer are not included in the public dataset we used). To construct the sample, we first identified all hospitals in the 2018 AHA Annual and IT Supplement surveys. We then matched hospitals to the list of hospitals in Definitive. In some cases, Definitive treated a single AHA hospital as multiple hospitals (usually when two hospitals shared the same physical campus). In these cases, we combined Definitive data into the level of a single AHA hospital.

We leveraged Definitive and AHA IT supplement data together to determine in which specific HIE network(s) each hospital participated, such that we could determine which pairs were connected because they participated in the same network(s). We excluded from our definition of networks 2 forms of connectivity: point-to-point exchange based on individual interfaces and Direct messaging as these do not meet the typical definition of a network. We followed a somewhat different approach to assign network participation for different types of networks because our 2 data sources tracked them differently. First, community HIE networks (also referred to as health information organizations or regional health information organizations) are vendor-agnostic and typically stand-alone entities that connect provider organizations in a given geographic region.[8,9] In the AHA IT survey, participation in these networks is measured by a yes/no question, while the Definitive data lists the specific community network in which a hospital participates. We took a conservative approach for considering a hospital as not participating by requiring that both sources indicated as such and otherwise consider a hospital as participating in the specific network(s) listed in Definitive. We also excluded hospitals that reported participating in a community HIE network in the AHA data but had no specific community HIE network listed in the Definitive data. This excluded 1129 hospitals, a number that suggests that the Definitive data collection process does not robustly capture this type of HIE network participation (See Appendix for further details).

Second, vendor HIE networks (eg, Epic's Care Everywhere) are designed to connect clients of specific health IT vendors while national HIE networks (eg, CommonWell, Carequality, and e-Health Exchange) are designed to facilitate cross-cutting connectivity but still rely on capabilities provided by a select group of health IT vendors. The AHA IT survey asked about participation in 5 specific national networks (CommonWell Health Alliance, e-Health Exchange, Carequality, DirectTrust, and the Patient-Centered Data Home) while the Definitive data lists the specific vendor and/or national network in which a hospital participates. We considered hospitals as participating in a given national/vendor network if they were listed as participating in that network in either the AHA IT supplement or Definitive data and reconciled network names across data sources. We excluded DirectTrust and Patient-Centered Data Home from the set of national networks to be consistent with our definition of a network. However, we did examine their adoption and overlap with the other types of networks (Appendix Fig. 1, Supplemental Digital Content 1, http://links.lww.com/MLR/C507).

After assigning each hospital to the specific community, vendor, and/or national HIE network(s) in which it participated—or to no HIE network—we merged in the HOP data source to create a pair-level dataset and only retained pairs for which we had HIE network participation status for both hospitals. Lastly, we removed any pairs of hospitals that belonged to the same multihospital system (based on the AHA system identifier) because these pairs often use the same EHR instance and therefore do not need to join a network to share patient information. Our final analytic dataset is at the hospital pair level. It includes 16,433 hospital pairs (comprised of 1721 unique hospitals) and 6,492,232 total shared patients. Appendix Table 2, Supplemental Digital Content 1, http://links.lww.com/MLR/C507 splits the full set of nonfederal acute care hospitals in United States (n = 4518) to compare the 1721 hospitals in our sample to the 2827 not in our sample.

Since our sample only represents a portion of the nonfederal acute care hospitals in the United States and only a portion of the hospital pairs in the HOP dataset (ie, those for which we could establish HIE network participation status for both hospitals in the pair), we used inverse probability weights to create nationally representative measures at both the hospital and hospital pair levels. Hospital-level weights were generated by predicting whether or not the hospital was in our sample based on characteristics of the hospital (multihospital system membership, critical access status, teaching status, ownership, hospital size, state and core-based statistical area type). Pair-level weights were generated by predicting whether or not the pair was in our sample based on characteristics of the pairs (distance between hospitals, critical access status of each hospital, number of patients shared between hospitals, proportion of all patients shared between hospitals, urban/rural location, system membership, ownership status, teaching status, size, and state of each hospital in the pair) to adjust our measures to be nationally representative.

Analytic Approach

We first produced measures of whether: (1) neither hospital in the pair participated in any network; (2) 1 of the 2 hospitals participated in any network; (3) both participated but the networks were different (such that the 2 hospitals could not share data with each other); or (4) both participated and the network was the same (the only option that we define as able to share data). We produced 2 sets of measures: (1) those that weighted connectivity between hospital pairs by the number of patients shared between those hospitals to represent the likelihood that a patient who is treated by 2 hospitals is treated by electronically connected hospitals; and (2) those without this weighting that capture the percent of pairs that fall into each category of connectivity. Given that 2 of the large national networks (Carequality and CommonWell) established connectivity to each other in 2019, we recalculated these proportions assuming that the 2 were connected.

Next, we measured the extent to which the 2 different types of networks—community HIE networks and vendor/national HIE networks—are providing overlapping or complementary connectivity. To do this, we measured the shared patient weighted percent of pairs connected by a vendor/national HIE network, a community network, both, and neither, which we report as a Venn Diagram.

Finally, we identified the characteristics—both of individual hospitals comprising the pair and their relationship to each other—that predict when a shared patient is treated by a pair of hospitals that is connected or not. We constructed a multivariable linear probability model that predicted whether a hospital pair is connected (ie, both on the same network) or not (any other category—eg, neither on a network, both on a network but different).

We selected 9 focal predictors based on prior literature examining interhospital networks of patients.[17,19–21] They are: (1) the number of patients shared by the pair of hospitals; (2) the importance of the relationship to each hospital (measured as the proportion of the larger and smaller hospitals total volume of shared patients made up by a specific pair); (3) the total number of patients each hospital shares with other hospitals (divided at the median); (4) the distance (in miles) between the hospitals; (5) ownership of hospitals in the pair (both nonprofit; both government; both for-profit; 1 nonprofit and 1 government; 1 nonprofit and 1 for-profit; 1 government and 1 nonprofit; 1 government and 1 for-profit); (6) system membership (neither in a system, 1 in a system, both in different systems); (7) the geographic location (measured as metropolitan, micropolitan or rural status of each hospital in the pair); (8) level of competition of the local market, defined by a Herfindahl-Hirschman Index of the Hospital Referral Region by hospital beds within each system (both low; both medium; both high; 1 low competition 1 medium competition market; 1 low and 1 high; 1 medium and 1 high); and (9) Accountable Care Organization (ACO) participation status (whether each hospital participated in an ACO or not).

In our models, we controlled for 2 other characteristics that might confound our relationships of interest: teaching status (medical school/residency program vs. no teaching program of each hospital in the pair) and size of each hospital in the pair (based on number of beds). We used 2-way clustered standard errors to account for multiple observations for each individual

TABLE 1. HIE Network and Hospital Characteristics (2018)

HIE Networks	N
Total HIE networks	127
National/vendor HIE networks	32
Community HIE networks	95
Hospitals	N (Weighted* %)
Total	1721
With national/vendor HIE network	1152 (61)
With community HIE network	1145 (58)
With either network type	1477 (79)
Networks per hospital	Weighted mean (SE)
Number of networks (either type)	1.6 (1.3)
Number of national/vendor HIE networks	1.0 (1.0)
Number of community HIE networks	0.6 (0.6)

*Hospital weights represent the inverse probability of being included in the sample based on the following hospital characteristics: critical access hospital status, system membership, teaching status, ownership, number of beds, state and core-based statistical area type.

HIE indicates health information exchange.

hospital across pairs. Finally, we used inverse probability weights to generalize to the population of hospital pairs.

RESULTS

Measures of Connectivity

In total, hospitals in our sample participated in 127 HIE networks. Thirty-two of these were vendor/national HIE networks and 95 were community HIE networks (Table 1). Seventy-nine percent of hospitals participated in at least one HIE network, with 61% participating in a vendor/national network and 58% participating in a community network. On average, each hospital participated in 1.6 networks: 1.0 vendor/national networks and 0.6 community networks.

Overall, 64% of shared patients received care from a pair of hospitals on the same network(s) (Fig. 1). Of the remaining 35%: (1) 14% of shared patients received care from hospitals that both participated in a network but did not participate in the same network; (2) 21% of shared patients received care from hospitals for which only 1 of 2 hospitals participated in an HIE network; and (3) 2% of shared patients received care from hospitals for which neither participated in an HIE network. If we treated hospitals that participated in CommonWell and Carequality as connected, the percent of shared patients treated by connected hospitals increased from 64% to 66%, while the 13% that received care from hospitals on different networks decreased to 12%. This small magnitude increase derived largely from the fact that hospitals were already connected through another application or network and also that those uniquely connected by CommonWell and Carequality shared a relatively small number of patients. Measures that do not account for shared patient volume reflected lower levels of connectivity: 54% of hospital pairs (vs. 64% of shared patients) were on the same network(s) (Appendix Table 3, Supplemental Digital Content 1, http://links.lww.com/MLR/C507). For 27% of hospital pairs (vs. 14% of shared patients), both participated but did not participate in the same network. For 17% of hospital pairs (vs. 21% of shared patients), only 1 hospital participated. For 1% of hospital pairs (vs. 2% of shared patients), neither hospital participated.

There was substantial overlap in connectivity provided by vendor/national networks and community networks (Fig. 2). Seventeen percent of all shared patients were shared by hospitals connected by both types of networks,

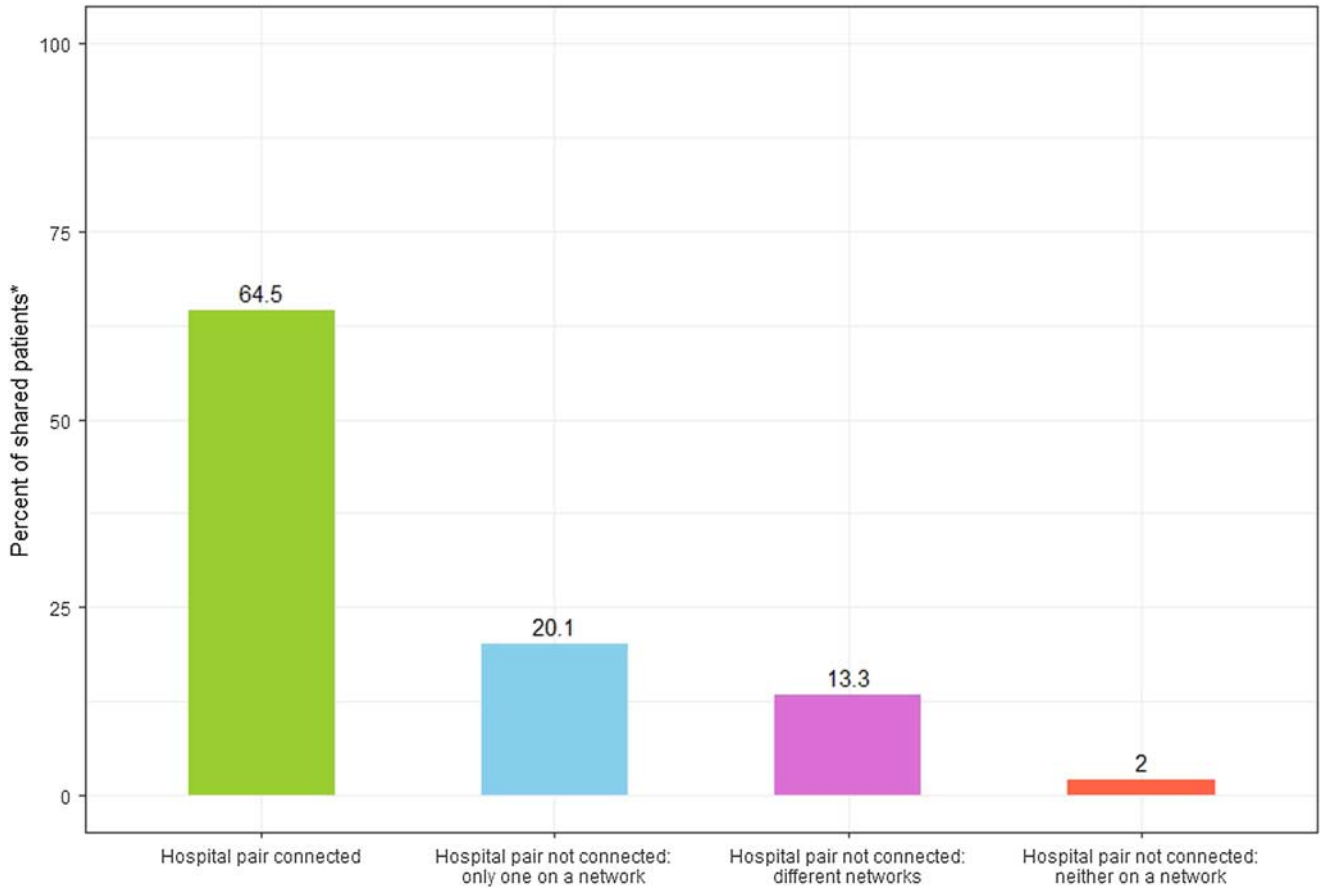

FIGURE 1. Percent of Medicare beneficiaries treated by 2 unaffiliated hospitals ("shared patient") by the connection status of the 2 hospitals: (1) pair connected by a Health Information Exchange (HIE) Network(s), (2) pair not connected because only 1 on a network, (3) pair not connected because hospitals are on different networks, or (4) pair not connected because neither is on a network, using 2018 data. "Connected" indicates connected by either community and/or vendor/national HIE network. Estimates are weighted by the inverse probability of sample inclusion among all pairs in the population.

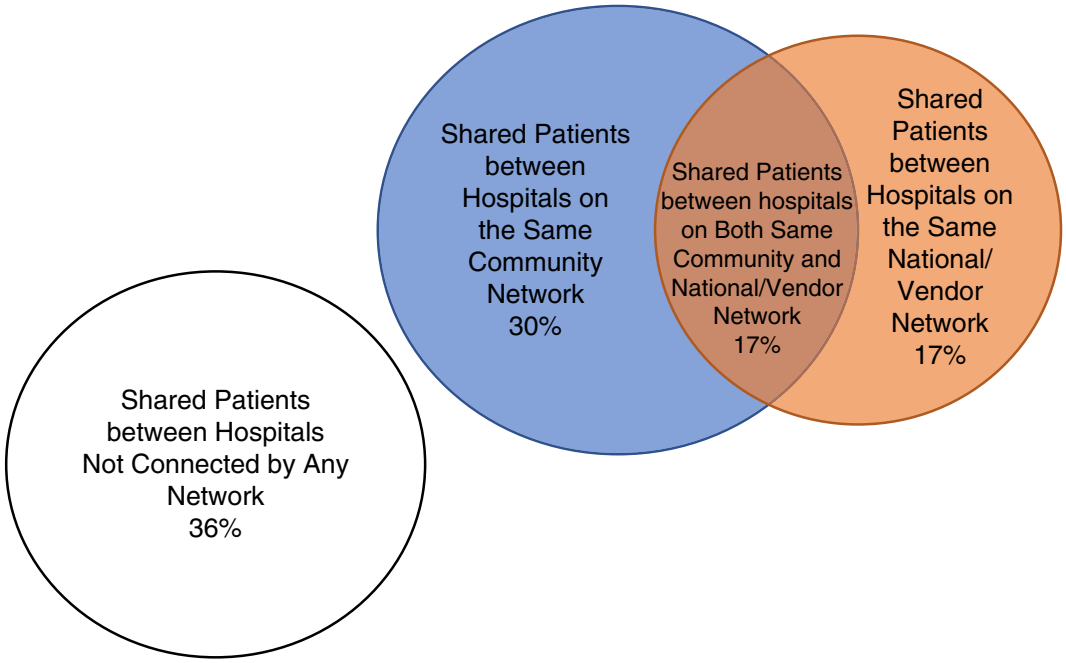

FIGURE 2. Percent of Medicare beneficiaries treated by hospital pairs connected by the same community network, national/vendor network, both or neither. Estimates are weighted by the inverse probability of sample inclusion among all pairs in the population.

representing 49% of all shared patients connected by vendor/national networks and 36% of all shared patients connected by community networks.

Predictors of Connectivity

Predictors of Patients Shared by Connected Versus Not Connected Hospitals

Several variables were associated with the likelihood that shared patients received care from connected hospitals (Fig. 3). When hospitals in the pair more routinely shared patients, they were more likely to participate in the same network; specifically, shared patients were 9.5 [95% confidence interval (95% CI): 4.42–14.5] and 16.0 (95% CI: 8.0–23.9) percentage points more likely to receive care from connected hospitals when the pair shared a medium and high volume (vs. low volume) of patients, respectively. However, the relative importance of the relationship to each hospital in the pair (measured as the proportion of each hospital's total volume of shared patients made up by the other hospital in the pair) was not a significant predictor. Pairs of hospitals that were closer in physical distance were more likely to be connected; for every additional 100 miles hospitals were from one another, they were 3 percentage points less likely to be connected (this correlation became weaker as hospitals were farther from one another, as indicated by the oppositely signed quadratic term). Our last relationship measure—the total number of patients each hospital shares with all other hospitals—was associated with a greater likelihood of connectivity. Specifically, when 1 hospital in the pair did not share many patients overall but the other hospital did, shared patients were 9.6 (95% CI: 2.4–16.8) percentage points less likely to receive care from connected hospitals.

Compared with patients treated by pairs of hospitals that were both nonprofit: (1) patients treated by pairs of hospitals that were both for-profit were 35.1 percentage points less likely to be treated by connected hospitals (95% CI: 15.7–54.4); (2) patients treated by pairs in which 1 was nonprofit and 1 was for-profit were 14.8 percentage points (95% CI: 3.4–26.2) less likely to be treated by connected hospitals; and (3) patients treated by pairs in which 1 was for-profit and 1 was government were 29.0 percentage points (95% CI: 12.5–45.5) less likely to be connected.

Compared with patients treated by pairs of hospitals located in metropolitan regions, pairs were less likely to be connected when one hospital was in a metropolitan area and the other was in a rural area (19.5 percentage points less likely; 95% CI: −31.8 to −0.7.1) as well as when both hospitals were rural (−29.3 percentage points less likely; 95% CI: −45.3 to −13.3).

Compared with patients treated by pairs of hospitals in low competition regions, patients treated by pairs of hospitals in medium and in highly competitive markets were 13.4 percentage points (95% CI: 2.6–24.1) and 14.9 percentage points (95% CI: 2.9–27.0) less likely to be treated by connected hospitals, respectively. Finally, compared with pairs of hospitals in which neither hospital was in an ACO, patients treated by pairs of hospitals in which both hospitals were in an ACO were 12.2 percentage points more likely to be treated by connected hospitals (95% CI: 1.8–22.6).

Full model results are presented in the Appendix Table 4, Supplemental Digital Content 1, http://links.lww.com/MLR/C507.

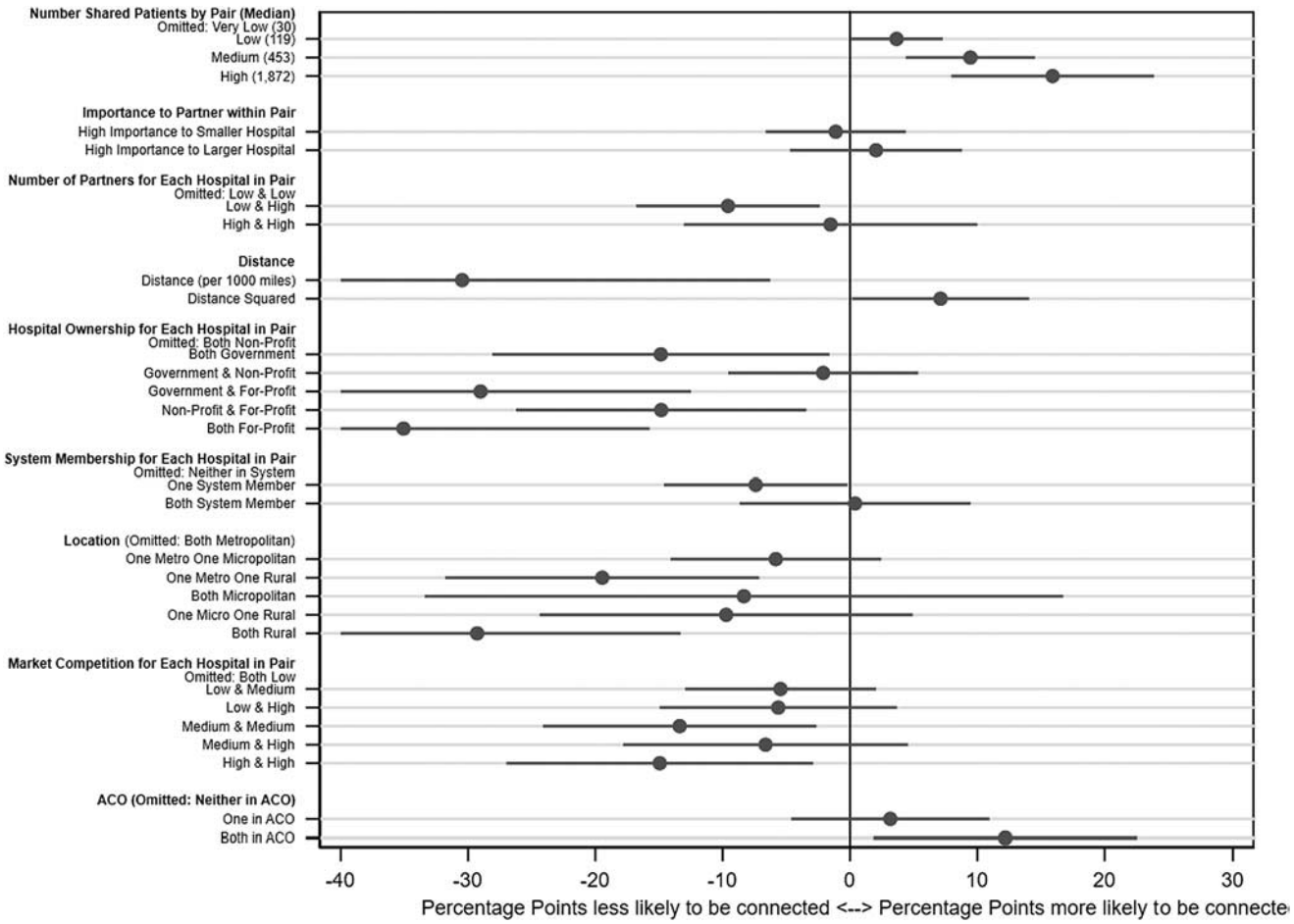

FIGURE 3. Association between likelihood that a shared Medicare beneficiary is treated by a pair of hospitals connected by an Health Information Exchange (HIE) network (versus not connected) and characteristics of the pair of hospitals, including median number of shared patients, relative importance of each hospital in the pair to the other, number of total hospitals with shared patients for each hospital in the pair, distance, hospital ownership, system membership, location type, market competition, and ACO participation. Model also includes teaching status and hospital size (full results available in Appendix Table 4). Point estimate represents coefficients from linear regression and lines represent 95% confidence intervals. Estimates are weighted by the inverse probability of sample inclusion among all pairs in the population.

DISCUSSION

In this study, we used a novel combination of data sources to create more meaningful measures of the level of electronic connectivity between US hospitals. Unlike prior measures that measure based on individual organizations[22,23] (ie, whether a given hospital does or does not participate in an HIE network), our measures reflect the network perspective (ie, when a hospital is connected to some hospitals but not others). Our measures also take a patient-centered view by integrating the volume of shared patients. If we continue to rely solely on prior measures, we risk overstating the extent to which connectivity aligns with where patients are receiving care, which is the ultimate policy goal. Going forward, our measures can be applied to later years of data to show how the trajectory of growth reflects network effects; for example, we might expect growth to be slow at the start when hospitals joining networks found few exchange partners but increase exponentially as networks mature since new participants get connected to many existing exchange partners.

Using our approach, we found that two-thirds of shared patients were cared for by hospitals on the same HIE network(s). Overall, this is encouraging because it suggests that these networks have emerged and recruited hospital participants in alignment with care patterns. Our multivariate models, in which hospital pairs treating higher volumes of shared patients were more likely to be connected, also supports this interpretation. Further, both types of networks we examined—community and vendor/national—cover a substantial volume of shared patients, lending support to the national policy strategy that has fostered development of these different types of networks.

However, almost all remaining patients were treated by hospitals in which both hospitals participated but in different networks or one hospital participated in a network while the other did not. These measures bring into focus the challenge of the patchwork system of HIE networks: a gap between hospital participation [79% of hospitals connected to a network(s)] and how often shared patients receive care from hospitals on the same network (65%). These findings motivate renewed focus on

strategies that connect existing HIE networks to each other in order to close these gaps. They also bring clarity to where additional efforts may be needed. For example, patients were less likely to be treated by connected hospitals when one hospital in the pair had many shared patients while the other did not. Because patterns of patient sharing are related to hospital size and role in the delivery system (eg, quaternary care hospital, community hospital), this indicates that hospitals that serve as referral centers in their local market may not participate in the same networks as small community hospitals. Thus, patients transferred or readmitted to referral centers from community hospitals may experience information fragmentation. Similarly, we found lower connectivity for patients treated by pairs that included for-profit hospital(s), hospitals that did not participate in ACOs, or hospitals located in competitive markets, suggesting that these hospitals may not perceive HIE to be a good investment.

As efforts continue to close connectivity gaps, our findings suggest which strategies may be most fruitful. Thirteen percent of shared patients were treated by pairs in which both hospitals were on networks but those networks were different. The developing Trusted Exchange Framework and Common Agreement (TEFCA), which is a national policy effort designed to facilitate connectivity between HIE networks, is well-positioned to close this gap.[24] Specifically, TEFCA is designed to establish network-to-network connectivity among and between the vendor/national HIE networks and the community HIE networks that we studied; in a recent survey, more than half of community HIE networks reported that they planned to participate.[9] However, as nothing yet compels participation in a TEFCA-based network it is too early to tell how many networks will join.

For the additional 20% of shared patients where one of the hospitals in the pair did not participate, the key is to get the second hospital connected—either to the same network or, as promoted by TEFCA, to a different network that can communicate with other networks. For both small community hospitals, rural hospitals, and for-profit hospitals, the growth of network-to-network connectivity may help as joining any given network should facilitate broad access to data and therefore more overall value. However, the factors that lead these hospitals to choose not to connect to HIE networks that would facilitate connectivity with close hospitals may similarly motivate continued lack of participation even with expanded network-to-network connectivity or other behaviors that limit sharing, including practices that may constitute information blocking. Indeed, prior evidence indicates that hospitals in competitive markets more often engage in behaviors that may constitute information blocking.[25] While it is hard to know what will motivate these hospitals to join networks and share data, it likely depends on showing that there are clear benefits to participating hospitals, such as preferential selection of connected hospitals as referral sources, in order to counterbalance concerns about the costs of participation and risks of sharing information about their patients with competitors.[20]

As efforts to increase connectivity advance, our findings also suggest the need to consider the unintended consequence of redundant connectivity. The substantial overlap between hospitals connected by community networks and vendor/national networks suggests potential avoidable cost and complexity for provider organizations. While it may be that the different types of networks are complementary in the functionality offered, it is also likely that these networks provide some redundant information and may result in complex workflows to reconcile that information. Efforts to ensure that participation in multiple networks presents limited costs to organizations, that redundant information is not presented to clinician, and that information from multiple networks is presented in similar workflows and formats may be necessary to drive value from these complementary networks. Otherwise, provider organizations would likely prefer a simplified approach where they are able to join a single network and be connected to all needed partners as well as receive all needed data sharing capabilities.

Limitations

Our study is subject to a number of limitations. First, although the most recent available national data, our data does come from 2018, and HIE network maturity and adoption have increased in the intervening years including community HIE networks connecting to national networks. Our intent was to develop improved measures of connectivity, based on shared patient volume, that can be updated over time as more current data becomes available. It will also be important to improve HIE network participation measure completeness, particularly to address the fact that no single source captured a robust picture of community HIE network participation. Second, our measures treat connectivity as a simple "yes or no" when in reality each network offers different functionality, usability, breadth of data exchanged, etc. It will be challenging, but important, for future work to attempt to further extend our measures to reflect the different types of connectivity. This limitation particularly applies to the overlap in connectivity by community and vendor/national networks, which may reflect complementary functionality from the different network types, rather than redundancy. Relatedly, hospitals have tremendous optionality for how they implement a given HIE network and the resulting robustness of exchange, which our measures fail to capture. Third, our measure of HIE excludes some forms of connectivity, including point-to-point exchange based on individual interfaces and Direct messaging. However, we suspect that the robustness of information exchanged and levels of use of these methods are relatively low and perhaps likely to shrink as national networks grow. Finally, our data only reflects connectivity between hospitals and not the broader care continuum. Our results may generalize to the more than half of all physicians employed by health systems given that the connectivity of the hospitals we studied likely extends to affiliated ambulatory settings.[26] However, our data is likely not reflective of independent provider organizations, many of whom likely lag behind hospitals in HIE participation.

CONCLUSION

In 2018, almost four-fifths of hospitals participated in an HIE network(s) and these hospitals were able to exchange information for almost two-thirds of shared patients. Efforts to connect hospitals participating in different HIE networks,

and to motivate for-profit hospitals, rural hospitals, and hospitals in competitive markets as well as markets without ACOs to join HIE networks could close current connectivity gaps. It is therefore important to continue current policy efforts to increase HIE participation and connections between existing networks, and to assess their ongoing impact based on measures of connectivity that take into account shared patient volume.

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