Care Fragmentation, Quality, and Healthcare Spending among Chronically Ill Patients

Abstract

Despite strong consensus that fragmentation of care contributes to high costs and poor quality, there is surprisingly little empirical evidence to support or refute this notion. Using claims data from a large commercial insurance company, we used regression analysis to examine the relationship between care fragmentation and both quality and costs of care for commercially-insured, chronically-ill patients. We found that patients of primary care providers (PCPs) in the highest quartile of fragmentation had a 32.8% chance of lacking evidence-based care compared to 25.9% among patients of PCPs in the lowest fragmentation quartile (p-value <0.001). Similarly, receiving care from PCPs with a high fragmentation index was associated with higher rates of preventable hospitalizations (9.1% versus 7.1%, p-value <0.001), and $4,542 higher healthcare spending (p-value <.001). To the extent that our empirical approach has identified causal effects, our findings indicate that policymakers and clinical leaders should continue to focus substantial efforts to reduce fragmentation in order to improve care and reduce healthcare spending.

Introduction

The U.S. health care system suffers from high costs that do not yield commensurately high levels of quality. Although there are many competing explanations for this inefficiency, one area of relatively broad consensus involves care fragmentation. According to the fragmentation hypothesis, care delivery too often involves multiple providers and organizations with no one entity effectively coordinating different aspects of care.(1) Poor coordination across providers may lead to suboptimal care, including important health care issues being inadequately addressed, poor patient outcomes, and unnecessary or even harmful services that ultimately both raise costs and degrade quality. It is precisely this hypothesis that has spurred policymakers to make investments in care models that emphasize care coordination, such as the patient-centered medical home model (PCMH) and accountable care organizations (ACOs).(2)

However, there is surprisingly little empirical evidence to either support or refute the fragmentation hypothesis. A key challenge to assessing the validity of the fragmentation hypothesis is determining whether higher costs and poorer outcomes are the result of fragmentation itself or simply a reflection of the fact that sicker patients both see more

providers (and thus look more "fragmented") and have worse health outcomes at higher costs. Understanding the relationship between fragmentation and quality as well as costs of care is critical for policymakers and clinical leaders struggling to find ways to improve the value of healthcare, especially for chronically ill patients.

Given the central importance of understanding the role of fragmentation in healthcare delivery, and given the paucity of national data that directly address these issues, we sought to answer three key questions: First, is there a relationship between the degree to which a patient's care is fragmented and the quality of care he or she receives? Second, what is the relationship between the degree to which a patient's care is fragmented and his or her total costs of care? Finally, are the quality and cost consequences of fragmentation apparent in pre-specified specific groups of patients with the most common chronic diseases?

Study Data and Methods:

Study Population and Data:

Our patient sample consists of 506,376 chronically ill enrollees in a major, nationwide private health plan. We only included individuals who met the following criteria: received their

insurance through a fully-insured employer participating in this plan; had at least one insurance claim associated with a primary care provider; and had claims between 2004 and 2007 with a primary diagnostic code corresponding to any of 15 major, common chronic conditions. These conditions included diabetes, hypertension, ischemic heart disease (IHD), congestive heart failure (CHF), and chronic obstructive pulmonary disease (COPD). The complete list of inclusion criteria, including the full list of conditions (and their associated ICD-9 codes) is included in the online supplemental appendix.(3)

The insurance company agreed to make available for research purposes the complete insurance claims history of these individuals—anonymized to preserve confidentiality—as well as a broad set of internally generated quality measures associated with their care. The claims dataset contains standard diagnostic and procedure codes as well as an anonymized, unique provider identifier associated with each claim. For providers, the dataset contains specialty and a unique billing address and practice identifier. We assigned all patients to the primary care provider associated with their claims. For patients with claims associated with more than one primary care provider, we assigned each patient to the primary care provider associated with the plurality of his or her health care costs.

Fragmentation Measure:

There is no standard operational measure of fragmentation. Previous studies of fragmentation in a Medicare setting have added up the number of providers that a patient sees during the course of treatment for a single health episode(4, 5) or during a year.(6, 7) While the counting approach is helpful in assessing the degree to which patients' care is fragmented, it is limited in its utility when assessing the degree to which fragmentation is associated with quality and costs of care.

An important limitation of the counting approach is that it doesn't reflect differences in the concentration of care. For example, a patient whose care is equally divided between two providers would be labeled as having the same level of fragmentation as a patient whose care is almost exclusively handled by one provider but who briefly interacts with another. To address this problem, we measured care fragmentation in terms of a Herfindahl-Hirschman concentration index (HHI). The HHI is commonly used in economic studies of industrial structure and is usually a measure of the degree to which a market is concentrated among a small number of companies. We used the HHI to measure the degree to which a patient's care is concentrated among a set of providers. We constructed an HHI for each patient

by first calculating each provider's share of the total costs associated with that patient's claims. We then summed the square of the cost shares across all providers that a patient sees. A patient's care would be considered to be the least fragmented when all the care was from a single provider (and corresponds to an HHI of one). A patient's care would be considered maximally fragmented if his or her care were equally divided across a large number of providers (and corresponds to an HHI approaching zero as the number of providers increases).

To address the challenge that sicker patients are likely to have more "fragmented" care (because they generally see more providers), we focused on the style of care of each patient's PCP's as our marker for the patient's care fragmentation. Specifically, we calculated, for each patient, the fragmentation of their PCP's *other* patients, excluding the patient himself or herself. That is, we defined a patient's fragmentation score to be the concentration of care for all the *other* patients in his or her PCP's panel, reflecting that PCP's practice style and not that patient's severity of illness directly. Of course, it may be that sicker patients cluster among certain PCPs, a possibility which we address below in our modeling approach. We define the fragmentation score as one minus this average HHI so that the score is increasing as fragmentation increases.

Our fragmentation measure focuses on a specific dimension of fragmentation: the dispersion of care across multiple providers. Another important dimension of fragmentation captures information flow disruptions among the providers involved in a patient's care (8), as measured perhaps by the presence of a cohesive information system linking the providers. Our data do not speak directly to information flows among physicians, but this dimension of fragmentation is likely to be highly correlated with our notion of care dispersion, and their effects are likely to be complementary: a pattern of care that is dispersed over several physicians is likely to be particularly susceptible to the consequences of information discontinuities, and vice versa.

Quality and cost outcomes

Our principal quality measure was derived from a proprietary algorithm the health plan uses to detect potential gaps in care. The algorithm analyzes patients' medical and drug claims, diagnostic history, and laboratory results for indications of departures from best clinical practice, and triggers an alert that is sent to the provider. We refer to these alerts as potential gaps in care (PGCs). The algorithm generating the PGCs targeted over 500 different potential clinical issues, the most

frequent 20 of which are listed in the online supplement (Appendix Exhibit A2), which account for about two thirds of the total alerts issued. These are closely aligned to national quality measures such as those in the Healthcare Effectiveness Data and Information Set (HEDIS). The algorithm also generates measures of whether the detected issue was eventually resolved. Our four main quality outcomes are patient-level indicators for (1) whether any potential gap in care (PGCs) was generated; (2) number of PGCs generated; and (3) whether any PGC was left unresolved. We chose *a priori* to focus on whether any PGCs were generated as our primary quality measure of interest but we examined all four.

To assess patient outcomes, we examined hospitalizations that result from ambulatory care-sensitive conditions (ACSCs). These are conditions where effective ambulatory care should prevent or reduce the need for hospitalization.(9, 10) These potentially preventable hospitalizations are thus generally accepted as indicators of poor quality of ambulatory care. The measures were developed by the Agency for Healthcare Research Quality as Prevention Quality Indicators (PQIs) and we used their definitions to construct our measures.(11) Most of the conditions underlying PQIs are targets of the Potential Gaps in Care algorithms as well.

Finally, we examined total costs of care by assigning each claim a standardized Medicare payment rate (both because we did not have the proprietary reimbursement amounts from the health plan and because we wanted the results to be broadly generalizable). The standard rate was calculated as the sum of the Medicare relative value units (RVUs) corresponding to the claim's procedure code, holding fixed the geographical pricing cost index (GPCI) to standardize across locations.

Covariates of interest

Because we were concerned that sicker patients might cluster together among certain PCPs, we included covariates to account for underlying patient characteristics that might otherwise confound the relationship between fragmentation and our outcomes of interest. We used the hierarchical condition categories (HCC) created and used by the Centers for Medicare and Medicaid Services (CMS),(12) as a risk-adjustment tool in our analyses to account for differences in patient severity.

Statistical analysis

We divided our population of patients by quartile of the fragmentation measure and compared key demographic and clinical characteristics of patients across these four groups. Next, we

estimated the relationship between the fragmentation measure and our outcomes using regression models that accounted for age, gender, and the HCC risk-adjustment variables, clustering to account for correlation among patients assigned to a given provider. For each outcome we estimated a model specifying a linear effect of fragmentation scaled in units of a standard deviation. We also estimated a more flexible nonlinear specification using indicators for fragmentation quartile.

In our subgroup analyses we estimated the same set of models separately for patients in each of the five disease categories we chose *a priori*: diabetes, hypertension, ischemic heart disease, CHF, and COPD. Using the results of the regression analysis, we calculated regression-adjusted means for each of our cost and quality measures for each quartile of the fragmentation measure.

This study was approved by the Office of Human Research Administration at the Harvard School of Public Health, the Harvard University Committee on the Use of Human Subjects in Research, and the Boston University Institutional Review Board.

Study Results

Patient and provider characteristics

Patients whose primary care providers exhibited a more fragmented style were, on average, older and were more likely to be female, and were more likely to suffer from diabetes, hypertension, IHD, CHF, or COPD than patients whose primary care providers practiced in a less fragmented style (Exhibit 1). The patients of PCPs with more fragmented style of practice had a greater number of primary care visits in a given year (24 in the highest quartile versus 10 in the lowest, p-value for trend <0.001) as well as more specialist visits (24 in the highest quartile versus 4 in the lowest quartile, p-value for trend <0.001). Further, we found that patients of PCPs with the most fragmented practice style saw, on average, a much greater number of primary care providers (4.0 in highest quartile versus 2.3 in lowest quartile) as well as common types of specialists (Exhibit 1) than patients whose PCPs practiced in a less fragmented style.

Quality and patient outcomes

We found that a higher degree of fragmentation was associated with a higher number of potential gaps in care (PGCs) generated (Exhibit 2). A standard deviation increase in fragmentation was associated with a 3.9% absolute increase in the likelihood of

having at least one PGC. Across quartiles, this relationship held: 25.9% of patients in the lowest quartile of fragmentation had a PGC, compared to 32.8% of patients in the highest quartile (p-value across quartiles <0.001) (Exhibit 3). The patterns were similar for the number of PGCs (higher among patients in more fragmented practices), the likelihood of having any unresolved PGC and the total number of unresolved PGCs (Exhibit 2).

We found a similar relationship between fragmentation and rates of preventable hospitalizations: a standard deviation increase in fragmentation was associated with a 1.4% absolute increase in the likelihood of having a preventable hospitalization (Exhibit 2). The analyses examining fragmentation in quartiles gave similar results: approximately 7.1% of patients in the lowest fragmentation quartile had a preventable hospitalization in a given year compared to approximately 9.1% in the highest quartile (p-value for difference across quartiles <0.001) (Exhibit 4).

Finally, we found that fragmentation was associated with substantial increases in costs of care (Exhibit 5). A standard deviation increase in the fragmentation measure was associated with a $2,642 increase in costs over a median period of 35 months. In examining quartiles, we found that patients in the

most fragmented quartile had an average total cost of $10,396, compared to just $5,854 among those in the least fragmented quartile (Exhibit 6).

Fragmentation, costs and quality by individual diseases

When we examined each of the five pre-specified chronic disease groups independently, we found relatively similar effects across each. In each of the five conditions, the likelihood of having any PGC (our measure of a quality gap) was higher as fragmentation increased, as did the likelihood of having a preventable hospitalization. Finally, we found that costs were, in each of the five conditions, highest in the two quartiles with the greatest fragmentation and substantially lower in the quartiles with lesser fragmentation (Table 5).

Discussion

We examined the relationship between fragmentation and both quality and costs of care among a chronically ill, commercially-insured population and found that greater fragmentation was consistently associated with worse quality and higher costs.

Even among select subgroups of patients with common chronic diseases, receiving care from a primary care physician who exhibits a more fragmented style of practice was associated with greater gaps in quality, more preventable hospitalizations, and higher healthcare spending. Taken together, these findings offer new evidence that national policy efforts may benefit from a greater effort towards reducing the fragmentation of care that chronically ill patients often experience.

We could not directly examine why fragmentation was associated with worse quality and higher costs, although there are several potential explanations. One possibility is that with multiple providers each heavily involved in a patient's care, no single provider is able to ensure that the entirety of a patient's clinical needs are taken into account, leading to gaps in care as important issues go unaddressed.(13) The substantial coordination costs of managing input from specialists drives another possible explanation. Among PCPs with a fragmented style of care delivery, the time spent coordinating multiple specialists may be crowding out a primary care physician's direct efforts to provide optimal care to his or her patients.

The higher costs associated with fragmentation may be driven by unnecessary duplication of services, or additional testing that

results as patients see more and more providers, consistent with the findings here that patients with higher fragmentation saw a greater number of different providers of a given specialty type. Given the relatively poor exchange of clinical data among providers,(8) it is possible that each additional visit with a new provider led to more tests, especially as patients saw more specialists. Finally, it is possible that that differences in costs may have been driven by poor care coordination leading to more preventable hospitalizations.

Our study adds to prior literature on the issue of fragmentation in medical care. Pham et al. demonstrated that the average Medicare patient sees a median of two primary care physicians and five specialists over a two-year time period.(6) Schrag found that 17% of patients in New York experienced fragmented inpatient care, and that this was particularly common among Medicaid recipients.(14) Liu et al showed that, in a population of patients with diabetes and chronic kidney disease, increasing fragmentation was associated with higher rates of emergency department use.(15) Others have focused on the opposite phenomenon, that is, continuity of care, and demonstrated that high levels of continuity are associated with better preventive care, lower likelihood of hospitalization, and better patient

experience,(16, 17) though others have failed to find the same association.(18)

Our study has several limitations. First, some patients may have unobserved underlying health issues that make care more complex and that require more specialized services. It may be that it is the need for specialized services rather than fragmentation *per se* that leads to higher costs and lower quality. We attempted to address this in three ways: first, we used a fragmentation measure that is based on the *other* patients a physician sees, which removes a patient's own clinical conditions from the fragmentation measure; second, we included detailed covariates into the regression models; and finally, we used five relatively homogeneous populations (those with specific chronic diseases). However, none of these techniques is perfect and residual confounding remains a possibility.

Another potential limitation is that our sample comes from a single large health plan and for this reason likely includes only a subset of any provider's panel of patients. This feature of our data introduces measurement error into our fragmentation measure and this, in turn, likely reduces the magnitude and precision of our estimates. Thus our results may represent a conservative estimate of the relationship between fragmentation

and care and quality outcomes. Next, to the extent that the alerts triggered by the identified PGCs altered providers' behavior, the impacts we measured on other quality and cost outcomes are net of the potentially ameliorating effect of the PGC alerts, which would decrease the magnitude of any relationship we find between increasing fragmentation and worse quality. Finally, because our data are limited to a commercially insured population, whether other patients, such as the elderly on Medicare, experience similar effects is unclear.

Conclusion

In summary, we found that more fragmented care is associated with lower quality and higher costs among non-elderly, chronically ill patients. The effects were sizeable, and to the extent our empirical approach has identified causal effects, they suggest that policymakers and clinical leaders should continue to focus substantial efforts to reducing fragmentation in order to improve care and reduce healthcare spending.

References

1. Elhauge E, editor. The Fragmentation of U.S. Health Care: Causes and Solutions. Oxford: Oxford University Press; 2010.
2. McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, et al. The quality of health care delivered to adults in the United States. N Engl J Med. 2003;348(26):2635-45.

3. To access the Appendix click on the Appendix link in the box to the right of the online article.
4. Cebul R, Rebitzer J, Taylor L, Votruba M. Organizational Fragmentation and Care Quality in the US Health Care System. In: Elhauge E, editor. The Fragmentation of US Health Care: Causes and Solutions. Oxford: Oxford University Press; 2010.
5. Hyman D. Health Care Fragmentation: We Get What We Pay For In: Elhauge E, editor. The Fragmentation of US Health Care: Causes and Solutions. Oxford: Oxford University Press; 2010.
6. Pham HH, Schrag D, O'Malley AS, Wu B, Bach PB. Care patterns in Medicare and their implications for pay for performance. N Engl J Med. 2007;356(11):1130-9. Epub 2007/03/16.
7. Pham HH, O'Malley AS, Bach PB, Saiontz-Martinez C, Schrag D. Primary care physicians' links to other physicians through Medicare patients: the scope of care coordination. Ann Intern Med. 2009;150(4):236-42. Epub 2009/02/18.
8. Vest JR, Gamm LD. Health information exchange: persistent challenges and new strategies. J Am Med Inform Assoc. 2010;17(3):288-94. Epub 2010/05/06.
9. Saha S, Oster A, Bindman A, editors. Impact of the Oregon Medicaid Demonstration on Preventable Hospitalization Rates. Academy Health Conference; 2003.
10. Billings J, Anderson GM, Newman LS. Recent findings on preventable hospitalizations. Health Aff (Millwood). 1996;15(3):239-49. Epub 1996/10/01.
11. Canadian Institute for Health Information. Health Indicators 2010. Statistics Canada; 2010 [cited 2013 April 9]; Available from: https://secure.cihi.ca/free_products/Healthindicators2010_en.pdf.
12. Pope GC, Kautter J, Ellis RP, Ash AS, Ayanian JZ, Lezzoni LI, et al. Risk adjustment of Medicare capitation payments using the CMS-HCC model. Health Care Financ Rev. 2004;25(4):119-41. Epub 2004/10/21.
13. Menec VH, Sirski M, Attawar D. Does continuity of care matter in a universally insured population? Health Serv Res. 2005;40(2):389-400. Epub 2005/03/15.
14. Schrag D, Xu F, Hanger M, Elkin E, Bickell NA, Bach PB. Fragmentation of care for frequently hospitalized urban residents. Med Care. 2006;44(6):560-7. Epub 2006/05/19.
15. Liu CW, Einstadter D, Cebul RD. Care fragmentation and emergency department use among complex patients with diabetes. Am J Manag Care. 2010;16(6):413-20. Epub 2010/06/22.
16. van Walraven C, Oake N, Jennings A, Forster AJ. The association between continuity of care and outcomes: a systematic and critical review. J Eval Clin Pract. 2010;16(5):947-56. Epub 2010/06/18.
17. van Walraven C, Mamdani M, Fang J, Austin PC. Continuity of care and patient outcomes after hospital discharge. J Gen Intern Med. 2004;19(6):624-31. Epub 2004/06/24.
18. Peikes D, Chen A, Schore J, Brown R. Effects of care coordination on hospitalization, quality of care, and health care expenditures among Medicare beneficiaries: 15 randomized trials. JAMA. 2009;301(6):603-18. Epub 2009/02/13.

List of Exhibits

EXHIBIT 1 (table)
Headline: "Patient Characteristics by Fragmentation Quartile"
Source: Authors' analysis
Notes: The table contains sample sizes and means of the variables in the left-hand column by quartile of the fragmentation index. The fragmentation measure is one minus the Herfindahl-Hirschman index of concentration of providers' care of a patient in terms of costs, as described in the text. PCP = primary care physician; IHD = ischemic heart disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease. Number of different physicians seen by specialty are averages conditional on seeing at least one of the given specialty type. Overall averages and a broader set of specialties are reported in Appendix Exhibit A1

EXHIBIT 2 (table)
Headline: "Impact of Fragmentation on Care Quality and Cost Measures"
Source: Authors' analysis
Notes: SD is Standard Deviation. The regression coefficient is the coefficient for each standard deviation change in our fragmentation measure in a regression that also controls for age, gender, and hierarchical clinical conditions (HCC) as described in the text. Standard errors allowing for arbitrary correlation at the provider level are in parentheses below the coefficient estimates. Regression-adjusted means by fragmentation index quartile are predicted values for each fragmentation quartile from a regression of the dependent variable on dummies indicating fragmentation quartile and the controls used in the linear regressions, holding other characteristics fixed at the mean.

EXHIBIT 3 (figure)
Headline: "Regression-Adjusted Probability of Potential Gap in Care"
Source: Authors' analysis
Notes: Predicted values for each fragmentation quartile from a regression of cost and quality outcomes on dummies indicating fragmentation quartile and the controls used in the linear regressions, holding other characteristics fixed at the first quartile mean.

EXHIBIT 4 (figure)
Headline: "Regression-Adjusted Probability of Ambulatory Care-Sensitive Hospitalization by Fragmentation Quartile"
Source: Authors' analysis
Notes: Predicted values for each fragmentation quartile from a regression of cost and quality outcomes on dummies indicating fragmentation quartile and the controls used in the linear regressions, holding other characteristics fixed at the first quartile mean.

EXHIBIT 5 (table)
Headline: "Impact of Fragmentation on Care Quality and Cost Measures by Chronic Condition"
Source: Authors' analysis
Notes: SD is Standard Deviation. The regression coefficient is the coefficient for each standard deviation change in our fragmentation measure, adjusting for age, gender, and hierarchical clinical conditions (HCC). Standard errors allowing for arbitrary correlation at the provider level are in parentheses below the coefficient estimates. Regression-adjusted means by fragmentation index quartile are predicted values for each fragmentation quartile from a regression of the dependent variable on dummies indicating fragmentation quartile and the controls used in the linear regressions, holding other characteristics fixed at the mean.

Exhibit 6 (figure)
Headline: "Regression-Adjusted Per-Patient Costs by Fragmentation Quartile"
Source: Authors' analysis
Notes: Predicted values for each fragmentation quartile from a regression of cost and quality outcomes on dummies indicating fragmentation quartile and the controls used in the linear regressions, holding other characteristics fixed at the first quartile mean.

Exhibit 1: Patient Characteristics by Fragmentation Quartile

Fragmentation	1 (least fragmented)	2	3	4 (most fragmented)
N	126,440	126,748	126,568	126,620
Age	43	45	48	49
Female	52%	56%	62%	62%
Diabetes	16%	17%	20%	23%
Hypertension	41%	43%	48%	52%
IHD	8%	11%	16%	18%
CHF	2%	3%	4%	5%
COPD	5%	6%	7%	8%
2 or more chronic conditions	16%	19%	25%	29%
Median PCP visits	10	13	22	24
Median specialist visits	4	9	19	24
Number of different physicians seen, by specialty:				
Primary care	2.28	2.81	3.64	3.95
Cardiology	1.82	2.08	2.63	2.91
Gastroenterology	1.36	1.44	1.68	1.77
Orthopedics	1.60	1.74	1.98	2.11
Dermatology	1.48	1.62	1.89	1.97
Fragmentation index	0.593	0.738	0.821	0.849

Notes: The table contains sample sizes and means of the variables in the left-hand column by quartile of the fragmentation index. The fragmentation measure is one minus the Herfindahl-Hirschman index of concentration of providers' care of a patient in terms of costs, as described in the text. PCP = primary care physician; IHD = ischemic heart disease; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease. Number of different physicians seen by specialty are averages conditional on seeing at least one of the given specialty type. Overall averages and a broader set of specialties are reported in Appendix Table A1.

Exhibit 2: Impact of Fragmentation on Care Quality and Cost Measures

Quality and Cost Measures	Overall Mean	Coefficient for one SD change in Fragmentation	Regression-adjusted Mean by Fragmentation Index Quartile			
			1 (least fragmented)	2	3	4 (most fragmented)
Any Potential Gap in Care (PGC)	29%	3.9% (0.22%)	26%	27%	30%	33%
Number of PGCs	0.67	0.12 (0.008)	0.58	0.61	0.71	0.80
Any unresolved PGC	22%	3.2% (0.21%)	20%	21%	23%	25%
Number of unresolved PGCs	0.43	0.08 (0.005)	0.37	0.39	0.45	0.56
Any Ambulatory-care sensitive care hospitalization	7.8%	1.4% (0.11%)	7.1%	7.4%	8.0%	9.1%
Cost	$8,008	$2,642 ($127)	$5,854	$6,403	$10,163	$10,396

Notes: SD is Standard Deviation. The regression coefficient is the coefficient for each standard deviation change in our fragmentation measure in a regression that also controls for age, gender, and hierarchical clinical conditions (HCC) as described in the text. Standard errors allowing for arbitrary correlation at the provider level are in parentheses below the coefficient estimates. Regression-adjusted means by fragmentation index quartile are predicted values for each fragmentation quartile from a regression of the dependent variable on dummies indicating fragmentation quartile and the controls used in the linear regressions, holding other characteristics fixed at the mean.

Exhibit 5: Impact of Fragmentation on Care Quality and Cost Measures by Chronic Condition

Condition	Overall Mean	Coefficient for one SD change in Fragmentation	Regression-adjusted Mean by Fragmentation Index Quartile			
			1 (least fragmented)	2	3	4 (most fragmented)
Diabetes						
Any Potential Gap in Care	61%	4.5% (0.53%)	58%	59%	62%	64%
Any ACSC hospitalization	19%	3.5% (0.35%)	18%	18%	20%	21%
Cost	$12,125	$4,219 ($241)	$9,095	$9,429	$14,687	$14,607
Hypertension						
Any Potential Gap in Care	40%	6.0% (0.28%)	36%	38%	41%	45%
Any ACSC hospitalization	12%	2.2% (0.18%)	11%	11%	12%	13%
Cost	$10,422	$3,489 ($177)	$7,636	$8,166	$12,927	$12,869
Ischemic Heart Disease						
Any Potential Gap in Care	48%	6.0% (0.50%)	44%	44%	48%	51%
Any ACSC hospitalization	19%	4.2% (0.36%)	17%	17%	19%	21%
Cost	$17,735	$6,434 ($313)	$13,633	$14,017	$20,852	$19,712
Congestive Heart Failure						
Any Potential Gap in Care	59%	5.8% (0.82%)	56%	56%	59%	62%
Any ACSC hospitalization	37%	5.1% (0.77%)	35%	35%	38%	39%
Cost	$25,868	$7,610 ($456)	$21,163	$20,572	$29,415	$28,304
COPD						
Any Potential Gap in Care	43%	6.4% (0.45%)	38%	41%	45%	51%
Any ACSC hospitalization	27%	3.8% (0.42%)	25%	27%	28%	29%
Cost	$16,885	$4,720 ($302)	$12,702	$13,438	$20,093	$19,368

Notes: SD is Standard Deviation. The regression coefficient is the coefficient for each standard deviation change in our fragmentation measure, adjusting for age, gender, and hierarchical clinical conditions (HCC). Standard errors allowing for arbitrary correlation at the provider level are in parentheses below the coefficient estimates. Regression-adjusted means by fragmentation index quartile are predicted values for each fragmentation quartile from a regression of the dependent variable on dummies indicating fragmentation quartile and the controls used in the linear regressions, holding other characteristics fixed at the mean.