

Fragmented Ambulatory Care and Subsequent Emergency Department Visits and Hospital Admissions Among Medicaid Beneficiaries

Lisa M. Kern, MD, MPH; Joanna K. Seirup, MPH; Mangala Rajan, MBA; Rachel Jawahar, PhD, MPH; and Susan S. Stuard, MBA

Having highly fragmented ambulatory care, which is care spread across multiple providers without a dominant provider, has been associated with higher rates of emergency department (ED) visits and hospital admissions among Medicare beneficiaries.^{1,2} When patients have fragmented care, it is often difficult for providers to communicate adequately with each other, and adverse events may follow.^{3,4} However, patterns observed in Medicare may not be generalizable to other populations.⁵

The goal of this study was to determine if more fragmented ambulatory care is independently associated with more ED visits and hospital admissions, compared with less fragmented care, among Medicaid beneficiaries. We specifically sought to explore this issue while teasing apart the pattern of ambulatory care from the number of chronic conditions, because having fragmented care may affect patients differently depending on how many chronic conditions they have.⁶

The issue of fragmentation has become increasingly important with the emergence of value-based purchasing, which requires that providers become newly responsible for *all* of a patient's care, not just care that they themselves provide.⁷ In this context, understanding fragmentation and its consequences becomes essential for effective population health management. Thus, the rationale for this study is to generate data-driven insights that can inform the design of future interventions to improve care patterns and outcomes.

METHODS

Overview

We conducted a retrospective cohort study (2010-2012) of adult Medicaid beneficiaries who received care from physicians in the Hudson Valley region of New York to determine associations between fragmented ambulatory care and subsequent ED visits and hospital admissions. The Institutional Review Board of Weill Cornell Medicine approved the protocol.

Setting

The Hudson Valley region consists of 7 counties (Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, and Westchester) immediately

ABSTRACT

OBJECTIVES: Results of previous studies of Medicare beneficiaries have shown that more fragmented ambulatory care is associated with more emergency department (ED) visits and hospital admissions. Whether this observation is generalizable to Medicaid beneficiaries is unknown.

STUDY DESIGN: We conducted a 3-year retrospective cohort study in the 7-county Hudson Valley region of New York. We included 19,330 adult Medicaid beneficiaries who were continuously enrolled, were attributed to a primary care provider, and had 4 or more ambulatory visits in the baseline year.

METHODS: We measured fragmentation using a modified Bice-Boxerman Index. Cox proportional hazards models were used to determine associations between fragmentation score and ED visits or, separately, hospital admissions, adjusting for age, gender, and chronic conditions.

RESULTS: The average beneficiary had 15 ambulatory visits in the baseline year, spread across 5 providers, with the most frequently seen provider accounting for 48% of the visits. One-fourth of the sample had more than 20 ambulatory visits and more than 7 providers, with the most frequently seen provider accounting for fewer than 33% of visits. For every 0.1-point increase in fragmentation score, the adjusted hazard of an ED visit over 2 years of follow-up increased by 1.7% (95% CI, 0.5%-2.9%). Having more fragmented care was not associated with a change in the hazard of a hospital admission.

CONCLUSIONS: Among Medicaid beneficiaries, having more fragmented care was associated with a modest increase in the hazard of an ED visit, independent of chronic conditions. Fragmented ambulatory care may be modifiable and may represent a novel target for improvement.

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TAKEAWAY POINTS

To determine any association between fragmented ambulatory care and subsequent healthcare utilization, this retrospective cohort study analyzed claims for 19,330 adult Medicaid beneficiaries.

- ▶ For every 0.1-point increase in fragmentation score, the adjusted hazard of an emergency department (ED) visit over 2 years of follow-up increased by 1.7% (95% CI, 0.5%-2.9%). For every 71 patients with high fragmentation, there is a risk of 1 additional ED visit.
- ▶ Having more fragmented care was not associated with a change in the hazard of a hospital admission.
- ▶ Fragmented ambulatory care may be modifiable and may represent a novel target for improvement.

north of New York, New York. At the time of the study, most healthcare in the region was delivered by physicians in small- and medium-sized private practices, using fee-for-service (FFS) reimbursement from multiple payers.⁸

Data

We used Medicaid claims for 2010-2012, extracting the following claim-level variables: patient study identifier (ID), patient date of birth, patient gender, date of service, rendering provider ID, Current Procedural Terminology (CPT) codes, and *International Classification of Diseases, Ninth Revision (ICD-9)* codes. We also extracted monthly patient-level enrollment data. Claims were included for both FFS and managed care products, with the same level of detail for the claims regardless of business line.

Study Sample

We first identified primary care physicians (PCPs; general internists and family medicine physicians) in the claims who had billing zip codes in the Hudson Valley region. We determined which Medicaid beneficiaries 18 years and older could be attributed to those PCPs, based on 2010 claims, using previously defined attribution logic.⁹ Ambulatory visits were defined by CPT codes, using a modified version of the definition from the National Committee for Quality Assurance (NCQA).¹⁰ Modifications restricted the definition to evaluation and management visits for adults in an office setting, excluding management-only visits (eg, dialysis, chemotherapy, and physical therapy) and non-office-based visits (eg, home visits and visits in nursing facilities). This definition excluded ED visits.

We excluded those who were not continuously enrolled in the baseline year, and we excluded beneficiaries with outlier observations (>99.9th percentile) for number of visits or number of unique providers, as those observations may have been erroneous. Next, we restricted the cohort to those with 4 or more visits in the baseline year, because calculating fragmentation with fewer visits can lead to statistically unstable estimates.² We required that beneficiaries be continuously enrolled in Medicaid for at least 1 more consecutive year, contributing data for 2 (2010-2011) or 3 (2010-2012) years. We excluded those who were in the hospital on January 1, 2011, because they were not at risk for an ED visit or hospital admission at the start of follow-up. We also excluded any beneficiary with a claim

for pregnancy and/or labor and delivery during the follow-up period, because ED visits and hospitalizations for those patients are expected.

Statistical Analysis

Independent variable. We measured fragmentation with the Bice-Boxerman Index (BBI) (eAppendix A [eAppendices available at ajmc.com]),¹¹ a previously validated measure.^{1,2,6,12,13} Raw BBI scores range from 0 (each visit with a different provider) to 1 (each visit with the same provider). Intermediate scores reflect

other patterns of care, with worse scores given to patterns with high dispersion (many providers) and low density (a relatively low proportion of visits by each provider). We transformed raw scores by reversing the direction (1 minus BBI score), so that higher scores reflect more fragmentation.

Dependent variables. We identified ED visits and hospital admissions in the claims using definitions from NCQA.¹⁰ Note that an "ED visit" reflected an ED visit that resulted in discharge (to home or elsewhere). If an ED visit resulted in hospital admission, it was considered part of the admission and the beneficiary was considered to have had only an admission.

Additional variables. We used ICD-9 codes to calculate the total number of chronic conditions for each beneficiary, using a set of 26 chronic conditions from the CMS Chronic Conditions Warehouse (eAppendix B).¹⁴ We determined the number of chronic conditions for each beneficiary (0, 1-2, 3-4, or ≥5). As a sensitivity analysis, we used the Charlson-Deyo Comorbidity Index instead of the count of chronic conditions.^{15,16}

Descriptive statistics. We calculated descriptive statistics for the study sample in the baseline year regarding the number of ambulatory visits, number of unique providers, proportion of visits with the most frequently seen ambulatory provider, and fragmentation scores. We tabulated the specialty codes for the providers who were most often the beneficiaries' most frequently seen provider and determined the proportion of those who were PCPs. We also determined the proportions of beneficiaries who had at least 1 ED visit and, separately, at least 1 hospital admission during the follow-up period, overall and stratified by number of chronic conditions.

Statistical models. We used Cox proportional hazards models for our analysis. Because fragmentation can change over time and because the hypothesized consequences of fragmented care may unfold relatively quickly, our models also treated fragmentation as time-dependent. We first calculated fragmentation using claims from the first 12 months (calendar year 2010) and then determined whether the beneficiary had an ED visit in month 13 (January 2011) or not. We then moved this window of observation by 1 month, recalculating the model using fragmentation in months 2 through 13 as a potential predictor of an ED visit in month 14, and so on. If the number of ambulatory visits in any 12-month window fell below

4 (making it difficult to calculate fragmentation scores), we carried forward the last fragmentation score that was based on 4 or more visits. We used the same approach in separate models predicting hospital admissions.

For each model, observation continued until an outcome or censoring occurred. For the ED visit models, censoring occurred if a beneficiary was admitted to the hospital (with the reasoning that the beneficiary was not at risk for an ED visit) or at the end of the beneficiary's continuous enrollment (December 31, 2011, or December 31, 2012). For the hospital admission models, censoring occurred only at the end of the beneficiary's continuous enrollment; any ED visit had no effect on the hospital models, because the beneficiary was still at risk for a hospital admission. We calculated the median observation time for each model.

Cox models were thus used to determine the association between fragmentation score (as a continuous variable) and the hazard of an ED visit (or hospital admission), adjusting for age, gender, and number of chronic conditions (as a categorical variable). We conducted sensitivity analyses adjusting for Charlson-Deyo Index scores instead of the number of chronic conditions.

In order to estimate excess events associated with high fragmentation, a supplementary analysis was conducted in which the index was dichotomized, with scores of 0.7 or greater defined as high scores. A generalized estimating equation model, with Poisson distribution and log link function, was used to calculate the attributable risk for high fragmentation, using the dichotomized fragmentation score and a fixed baseline exposure, adjusting for age, gender, and comorbidity.¹⁷

We considered *P* values <.05 to be statistically significant. We used SAS version 9.4 (SAS Institute; Cary, North Carolina).

RESULTS

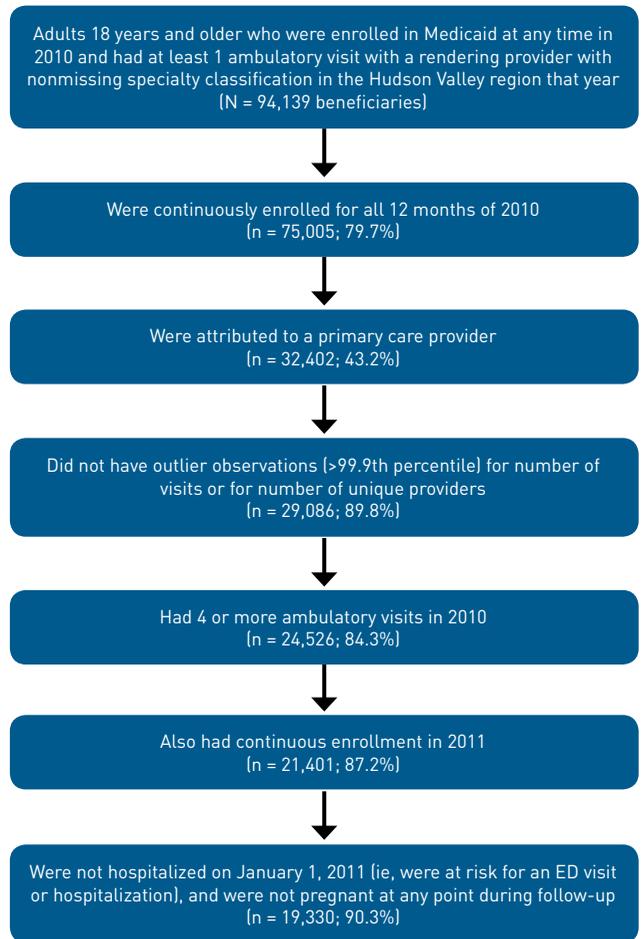
Study Sample

We identified 94,139 adult Medicaid beneficiaries who had at least 1 ambulatory visit with a provider in the Hudson Valley region in 2010 (Figure). Of those, 75,005 (79.7%) were continuously enrolled that year. Of those, 32,402 (43.2%) could be attributed to a PCP. Our final sample was composed of the 19,330 beneficiaries (59.7%) who did not have outlier observations for numbers of visits or providers, had 4 or more visits, had continuous enrollment for at least 1 more consecutive year, were not hospitalized on the first day of follow-up, and were not pregnant during follow-up (Figure).

Sample Characteristics

Among the 19,330 beneficiaries in our sample, the mean age was 55 years (Table 1). Nearly two-thirds of beneficiaries (63%) were women. Among those in the sample, 14% had 0 chronic conditions, 33% had 1 or 2, 28% had 3 or 4, and 25% had 5 or more. The average Charlson-Deyo Index score was 1.4. Most beneficiaries (89%) contributed data for 3 years, whereas the remainder (11%) contributed data for 2 years.

FIGURE. Derivation of the Study Sample



ED indicates emergency department.

Ambulatory Care at Baseline

The average beneficiary had 15 ambulatory visits in the baseline year, spread across 5 different providers, with the most frequently seen provider accounting for 48% of the visits (Table 1). For just over half of the beneficiaries (56.6%), the most frequently seen provider was a PCP (eAppendix C). One-fourth of the sample (those above the 75th percentile) had more than 20 ambulatory visits, had more than 7 different providers, and had fewer than 33% of visits with the most frequently seen provider. The mean (SD) fragmentation score was 0.71 (0.20).

ED Visits and Hospitalizations

One-third (33%) of the sample had an ED visit during the follow-up period, for a total of 6449 ED visits. The median observation time until an ED visit or censoring (for the ED visit models) was 1.2 years. The proportion of patients with at least 1 ED visit was similar regardless of the number of chronic conditions; for example, 34%

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TABLE 1. Characteristics of the Study Sample (N = 19,330), Their Ambulatory Visits and Fragmentation Scores During the Baseline Year, and Their ED Visits and Hospital Admissions Over 2 Years of Follow-up

Patient Characteristics	
Age in years, mean (SD)	55.2 (17.6)
Gender, female	63.2%
Number of chronic conditions*	
0	13.9%
1-2	32.7%
3-4	28.2%
≥5	25.3%
Charlson-Deyo Comorbidity Index score, mean (SD)	1.4 (1.8)
Ambulatory Visits	
Number of ambulatory visits per patient	
Mean (SD)	15.3 (11.0)
Median (range) ^b	12 (4-105)
IQR (25th percentile-75th percentile)	8-20
Number of unique ambulatory providers per patient	
Mean (SD)	5.4 (2.9)
Median (range)	5 (1-22)
IQR (25th percentile-75th percentile)	3-7
Proportion of visits with the most frequently seen ambulatory provider	
Mean (SD)	0.48 (0.19)
Median (range)	0.44 (0.08-1.00)
IQR (25th percentile-75th percentile)	0.33-0.57
Fragmentation score	
Mean (SD)	0.71 (0.20)
Median (range)	0.77 (0-1)
IQR (25th percentile-75th percentile)	0.64-0.84
ED Visits	
Proportion of patients with at least 1 ED visit during the study period	0.333
Median (range) observation time until ED visit or censoring	1.2 years (1 day-2.0 years)
Hospital Admissions	
Proportion of patients with at least 1 hospital admission during the study period	0.293
Median (range) observation time until hospital admission or censoring	2.0 years (1 day-2.0 years)

ED indicates emergency department; IQR, interquartile range.

*Percentages may not sum to 100 due to rounding.

^bBeneficiaries were included if they had 4 or more visits in the baseline year.

of beneficiaries with 0 chronic conditions had at least 1 ED visit compared with 33% with 5 or more chronic conditions (Table 2).

Nearly one-third (29%) of the sample was hospitalized during the follow-up period, for a total of 5658 hospital admissions. The median observation time until a hospital admission or censoring was 2.0 years. The proportion of patients with at least 1 hospital admission varied depending on the number of chronic conditions, with 11% of those with 0 chronic conditions having a hospital

TABLE 2. Numbers and Percentages of Medicaid Beneficiaries With ED Visits and Hospital Admissions During Follow-up (N = 19,330), Stratified by Number of Chronic Conditions^a

Number of Chronic Conditions	n	n (%) With Outcome	
		At Least 1 ED Visit	At Least 1 Hospital Admission
0	2678	922 (34)	302 (11)
1-2	6319	2331 (37)	1271 (20)
3-4	5451	1788 (33)	1668 (31)
≥5	4882	1408 (29)	2417 (50)
Total	19,330	6449 (33)	5658 (29)

ED indicates emergency department.

^aED visits are those that result in discharge. If a beneficiary has an ED visit that results in admission, the ED visit is considered part of the admission and only the admission is counted.

admission compared with 50% of those with 5 or more chronic conditions (Table 2).

Fragmentation, ED Visits, and Hospital Admissions

For every 0.1-point increase in the fragmentation score, the hazard of an ED visit increased by 1.7%, adjusting for age, gender, and number of chronic conditions ($P < .05$) (Table 3). The supplementary logistic model estimated that high fragmentation increased the risk of an ED visit by 1.4%, adjusting for age, gender, and number of chronic conditions ($P < .05$; data not shown). Results persisted when the Charlson-Deyo Index score was substituted for the number of chronic conditions (Table 3). There was no association between fragmentation score and the hazard of a hospital admission.

DISCUSSION

In this study of 19,330 Medicaid beneficiaries, having more fragmented care was associated with a modest 1.7% increase in the adjusted hazard of an ED visit, independent of the number or severity of chronic conditions. The hazard of a hospital admission was strongly associated with the number and severity of chronic conditions; having highly fragmented care did not increase this hazard further.

This effect size of a 1.7% increase in the adjusted hazard of an ED visit for each 0.1-point increase in fragmentation score in the Medicaid population is smaller than the 4% to 8% increase in the adjusted hazard of an ED visit previously observed for each 0.1-point increase in fragmentation score in the Medicare population.¹ However, that Medicare study included only beneficiaries with congestive heart failure, chronic obstructive pulmonary disease, or diabetes,¹ making that study's population sicker than average for Medicare and sicker than average compared with Medicaid.

Although the Cox models estimated a 1.7% increase in hazard for a 0.1-point increase in the fragmentation index, we frequently observed an even wider range of fragmentation scores than 0.1-point differences. For example, beneficiaries at the 75th percentile for fragmentation scores had scores that were 0.2 points greater, on

TABLE 3. Association Between Fragmentation Scores and the Outcomes of ED Visits and Hospital Admissions

	Model 1 Hazard Ratio [95% CI]	Model 2 Hazard Ratio [95% CI]
ED visits		
Fragmentation score (for every 0.1-point increase)	1.017 (1.005-1.029)*	1.017 (1.005-1.029)*
Gender (female vs male)	1.25 (1.19-1.32)*	1.27 (1.21-1.34)*
Age (for every 1-year increase)	0.995 (0.990-0.999)*	0.984 (0.982-0.985)*
Chronic condition count category		
0	Reference	-
1-2	1.48 (1.37-1.60)*	-
3-4	1.72 (1.57-1.88)*	-
≥5	2.05 (1.85-2.26)*	-
Charlson-Deyo Comorbidity Index score (for every 1-point increase)	-	1.07 (1.06-1.09)*
Hospital admissions		
Fragmentation score (for every 0.1-point increase)	1.00 (0.99-1.11)	1.08 (0.97-1.22)
Gender (female vs male)	0.89 (0.85-0.95)*	0.95 (0.90-1.00)
Age (for every 1-year increase)	1.009 (1.008-1.011)*	1.018 (1.017-1.020)*
Chronic condition count category		
0	Reference	-
1-2	1.64 (1.44-1.86)*	-
3-4	2.40 (2.10-2.73)*	-
≥5	4.25 (3.72-4.85)*	-
Charlson-Deyo Comorbidity Index score (for every 1-point increase)	-	1.24 (1.22-1.25)*

ED indicates emergency department.
*P < .05.

average, than beneficiaries at the 25th percentile (0.84 vs 0.64). What kind of change in visit pattern would yield a 0.1- or 0.2-point difference in fragmentation scores? To illustrate this, we provide a nomogram (eAppendix D), which shows how fragmentation scores increase as the proportion of visits with the most frequently seen provider decreases, among those with 12 visits (the median number of visits observed in our sample). This nomogram displays the results for all possible patterns of care for that visit count (with 1-12 different providers and all possible distributions of visits across those providers). This is a useful illustration of the sensitivity of fragmentation scores to changes in the proportion of visits with the most frequently seen provider for a given number of visits. Although the nomogram displays results only for those with 12 visits, the negative correlation holds across all visit counts. For those with 12 visits, increasing the proportion of visits with the most frequently seen provider from 33% (4 of 12 visits) to 50% (6 of 12 visits) decreases the fragmentation score by approximately 0.15 points, with variation depending on the exact distribution of the remaining visits to other providers (eAppendix D).

If we convert the excess risk calculated in the supplementary analysis to an absolute count of excess ED visits, the analysis

shows that for every 71 patients with high fragmentation, there is a risk of 1 additional ED visit. This is equivalent to approximately 177 ED visits attributable to high fragmentation in our sample. Because the median charge for an ED visit nationally is \$1233, this could account for an estimated \$200,000 in excess ED expenditures in our sample of approximately 19,000 beneficiaries.¹⁸

There are several possible interpretations of an association between more fragmented ambulatory care and an increased hazard of ED visits. Having more fragmented ambulatory care could cause more ED visits, if gaps in communication among providers caring for the same patient cause adverse events (eg, from drug–drug interactions) that require emergency care.¹⁹ Alternatively, beneficiaries with more fragmented ambulatory care could be the same beneficiaries who choose to use the ED more frequently, meaning that fragmented ambulatory care and use of the ED could be correlated but not causally related. In that case, having more fragmented ambulatory care could be a marker of a tendency to use the ED. Medicaid beneficiaries may go to the ED appropriately, given their medical symptoms,^{20,21} but it is possible that those symptoms might have been prevented or adequately managed if ambulatory care had been less fragmented. This study thus reveals a novel finding: The *pattern* of care that Medicaid beneficiaries receive in the

ambulatory setting may predict subsequent ED visits.

That we did not observe an association between fragmented ambulatory care and hospital admissions appears to be explained by the strong association between chronic conditions and hazard of hospital admission. That is, the burden of illness was such a strong predictor of hospital admission in this sample that it dwarfed any contribution by fragmentation. The point estimates for fragmentation were greater than 1.00, but they were not statistically significant and the CIs were wider than for ED visits. Larger sample sizes might be needed to detect small effects of fragmentation on hospital admission in the Medicaid population.

Limitations

This study has several limitations. It is observational, and we cannot rule out unmeasured confounding. We do not measure communication among providers, and not all fragmented care should be interpreted as uncoordinated care. We also cannot determine the medical appropriateness of the patterns observed. Finally, this analysis took place in 1 region, which may not be generalizable, although the multipayer, multiprovider characteristics of this region are found in other communities.

CONCLUSIONS

The results of this study have several implications. As reimbursement in Medicaid shifts from FFS to value-based purchasing,²² providers need new strategies for managing the quality and cost of care for populations of beneficiaries. Measuring fragmentation in the ambulatory setting creates the possibility of identifying patients with highly fragmented care and intervening to avert preventable ED visits. An example of an intervention that could reduce fragmentation is the creation of alerts in electronic health records to notify providers in real time if they are seeing patients who have highly fragmented care.²³ This kind of intervention has been developed for a pediatric population in a single clinic²³ but not yet for an adult population across multiple sites of care. Other types of interventions could be designed at the patient level (eg, educational interventions on the potential harms of fragmented care), practice level (eg, changes in scheduling systems to decrease the extent of cross-coverage), and payer level (eg, providing financial incentives that reward success in decreasing fragmentation). Future studies could test the effectiveness of such interventions in terms of their impact on ambulatory fragmentation and subsequent outcomes (eg, ED visits).

Previous studies of fragmentation focused almost exclusively on Medicare beneficiaries. This is the first study to our knowledge to measure associations between ambulatory fragmentation and subsequent healthcare utilization in a Medicaid population. We included beneficiaries with continuous coverage who had at least 4 ambulatory visits in the baseline year, thus distinguishing the problem of fragmentation from the problem of churning (in which beneficiaries temporarily lose coverage)²⁴ and from the problem of not having a source of ambulatory care.²⁵ We found an association between more fragmented ambulatory care and a modest independent increase in the hazard of ED visits. This is important, because fragmentation is potentially modifiable and could serve as a novel target for improvement. Reducing fragmentation could potentially improve ambulatory care quality while decreasing subsequent ED utilization and cost. ■

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Author Affiliations: Department of Medicine (LMK, MR) and Department of Healthcare Policy and Research (LMK, JKS, RJ), Weill Cornell Medicine, New York, NY; Lake Fleet Consulting (SSS), Irvington, NY.

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Address Correspondence to: Lisa M. Kern, MD, MPH, Weill Cornell Medicine, 420 E 70th St, Box 331, New York, NY 10021. Email: lmk2003@med.cornell.edu.

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eAppendix A. The Bice-Boxerman Index (BBI)¹¹

$$BBI = \frac{\left(\sum_{i=1}^p n_i^2\right) - n}{n(n-1)}$$

Where n = total number of visits in a 12-month period
 n_i = number of visits to provider i
 p = total number of providers

eAppendix B. Chronic conditions listed in the Centers for Medicare and Medicaid Services
Chronic Conditions Warehouse¹⁴

1. Acquired hypothyroidism
2. Acute myocardial infarction
3. Alzheimer's disease*
4. Alzheimer's disease and related disorders or senile dementia*
5. Anemia
6. Asthma
7. Atrial fibrillation
8. Benign prostatic hyperplasia
9. Cataract
10. Chronic kidney disease
11. Chronic obstructive pulmonary disease and bronchiectasis
12. Depression
13. Diabetes
14. Glaucoma
15. Heart failure
16. Hip/pelvic fracture
17. Hyperlipidemia
18. Hypertension
19. Ischemic heart disease
20. Osteoporosis
21. Rheumatoid arthritis / osteoarthritis
22. Stroke / transient ischemic attack
23. Female / male breast cancer
24. Colorectal cancer
25. Prostate cancer
26. Lung cancer
27. Endometrial cancer

*These two categories were combined to avoid double-counting Alzheimer's disease, such that the main analysis considered 26 distinct categories.

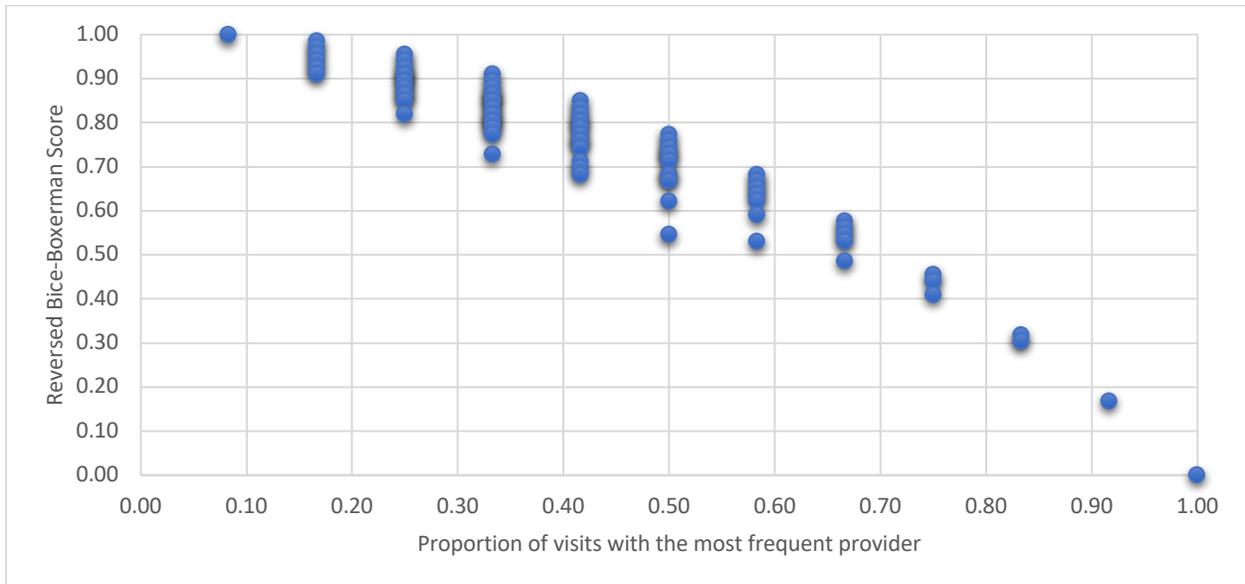
eAppendix C. Specialty Codes for the Providers Who Were Most Often the Beneficiaries' Most Frequently Seen Provider

Provider Specialty Code	Description of the Provider Specialty Code	Proportion of Beneficiaries in the Study with this Specialty Code for the Most Frequently Seen Provider*
060	Internal Medicine	25.3%
914	General Medicine – Clinic Specialty	18.4%
050	Family Practice	9.1%
978	Preferred Primary Care Clinic	3.8%
062	Cardiovascular Disease	3.4%
778	Podiatry	2.5%
064	Gastroenterology	2.4%
100	Ophthalmology	2.4%
068	Pulmonology	1.9%
067	Nephrology	1.7%
089	Obstetrics and Gynecology	1.7%
063	Endocrinology	1.5%
	Cumulative total†	74.1%

*The first four rows all represent primary care (accounting for the most frequently seen provider for 56.6% of beneficiaries).

†The remaining 25.9% of the beneficiaries had other specialties for their most frequently seen provider, with each of those specialties accounting for $\leq 1.5\%$ of beneficiaries in the sample.

eAppendix D. An Illustrative Nomogram Showing How Fragmentation Scores (reversed Bice-Boxerman scores*) Vary With the Proportion of Visits With the Most Frequently Seen Provider, Among Those With 12 Ambulatory Visits



*Higher scores reflect more fragmentation of care.