# Care Fragmentation and Emergency Department Use Among Complex Patients With Diabetes

Constance W. Liu, MD, PhD; Doug Einstadter, MD; and Randall D. Cebul, MD

**Objective:** To evaluate the association between patterns of fragmented care and emergency department (ED) use among adult patients with diabetes and chronic kidney disease.

**Study Design:** Observational study in an open healthcare system.

**Methods:** The study sample included patients with diabetes and chronic kidney disease (mean estimated glomerular filtration rate, 20-60 mL/min) and with an established primary care provider. Dispersion of care was defined by a fragmentation of care index (range, 0-1), with zero reflecting all care in 1 outpatient clinic and 1 reflecting each visit at a different clinic site. We used a negative binomial model to estimate the influence of fragmentation on ED use after adjusting for patient demographic characteristics, insurance, diabetes control, and number of comorbidities; results are reported as incidence rate ratios and associated 95% confidence intervals (CIs). The main outcome measure was the number of ED visits from 2002 to 2003.

**Results:** Of 3873 patients with diabetes having an established primary care provider, 623 (16.1%) had chronic kidney disease and comprised the final study sample. On average, patients made 19.0 (95% CI, 18.5-20.4) outpatient visits and 1.2 (95% CI, 1.1-1.4) ED visits over the 2-year period. The median fragmentation of care index was 0.48; 14.3% of subjects had a fragmentation of care index of zero. In the adjusted model, a 0.1-U increase in the fragmentation of care index was associated with a 15% increase in the number of ED visits (incidence rate ratio, 1.15; 95% CI, 1.09-1.21).

**Conclusions:** The posited benefits of specialist referrals among patients with complex diabetes may be partially negated by care fragmentation. Better models for care coordination and stronger evidence of the marginal benefits of referrals are needed.

*(Am J Manag Care. 2010;16(6):413-420)*

For author information and disclosures, see end of text.

Type 2 diabetes mellitus is associated with multiple comorbid illnesses, complications, and hospitalizations thought to be largely preventable by proper patient attention to self-care and by application of best practices of evidence-based care.[1] Nonetheless, outcomes of care among patients with diabetes fall far short of expectations. Annual costs of diabetes in the United States are estimated to be more than $130 billion.[2] Fewer than half of US patients with diabetes receive recommended health services,[3] and a large body of research documents that patients who are less likely to receive needed services are likely to be poorer, less educated, members of racial/ethnic minorities, older, and uninsured.[4] As with other ambulatory care–sensitive conditions, however, diabetes outcomes are thought to be improved by better continuity of care, usually defined by a preponderance of visits occurring with the same primary care provider. Emergency department (ED) use, which increased 26% between 1993 and 2003 to about 114 million visits annually, is thought to be a particularly sensitive measure to inadequate outpatient care.[5]

Providing coordinated continuity of care is challenging in managing the myriad complications that accompany diabetes. Attention to evidence-based guidelines for patients with diabetes even without comorbid conditions appropriately includes annual ophthalmology visits for dilated eye examinations and possibly visits for nutrition counseling and podiatric examinations.[6] Patients with diabetes whose glycemia is difficult to control are recommended more aggressive treatment through consultations or comanagement with a diabetes specialist.[6] Cardiac and neurologic consultations appropriately may be sought as cardiovascular, cerebrovascular, and neuropathic complications accrue. Professional nephrology organizations have called for earlier referral of patients having diabetes with evidence of renal impairment.[7] Accompanying obesity often requires additional referrals for weight management, coexisting sleep apnea, gastroesophageal reflux disease, and arthritis. Approximately 1 in 4 patients with diabetes has coexisting major affective disorders that may require comanagement with a psychiatrist.[8-11] In the context of evidence-based guidelines and customary standards of diabetes care, these frequently necessary referrals create the possibility of fragmentation (the dispersion of management of various aspects of a patient's care to several providers, which may include the patient's primary care provider or specialists); the effects of frequent re-

**In this article**
Take-Away Points / p414
**www.ajmc.com**
Full text and PDF

**Take-Away Points**

This investigation illustrates that seemingly appropriate referrals to subspecialty providers increased care fragmentation, which was associated with a higher rate of emergency department visits among patients with diabetes and chronic kidney disease.

- These findings extend previous work that highlights the association of discontinuity of care with worse clinical outcomes, patient dissatisfaction, and provider confusion regarding their roles in care for patients with diabetes.
- The evidence base for the design of optimal systems of care should be strengthened, with attention to the risks and effectiveness of referrals for patients with diabetes.

ferrals on the patient medical home,[12] patient-centered quality, and healthcare utilization are largely unknown.

In the present investigation, we examined the effects of care fragmentation on ED use in a particularly complex and vulnerable subgroup of patients having diabetes with kidney impairment. Our principal interest was to determine whether seemingly appropriate referrals to specialists for outpatient screening or consultation for coexisting conditions were offset by the potentially deleterious effects of care fragmentation. Emergency department use was selected as our principal outcome measure, as it is conventionally understood to be "preventable" by optimal ambulatory care of patients with diabetes.[13]

## METHODS

### Subjects and Setting

We selected adult patients having diabetes with chronic kidney disease to identify a homogeneous sample with regard to complexity and need for care. Patients eligible for inclusion in the study included all patients with diabetes older than 18 years and having 2 or more visits in the year before the study period to 1 of 10 primary care group practices within the MetroHealth System, a large public urban provider in Cuyahoga County, Ohio. We required 2 or more visits to the same site to increase the likelihood that these were patients and physicians who were in a continuous relationship, as well as to be consistent with American Diabetes Association recommendations that patients with diabetes have 1 primary care visit every 6 months.[14] Data were obtained from electronic medical records over a 2-year study period (2002-2003). Inclusion criteria were as follows: a diabetes mellitus diagnosis in an encounter before the study period (*International Classification of Diseases, Ninth Revision, Clinical Modification* [*ICD-9-CM*] code 250.xx), age older than 18 years (determined by age at the beginning of the study period), and the presence of chronic kidney disease, defined as a 2-year mean glomerular filtration rate (GFR) between 20 and 60 mL/min. The GFR was calculated using the Mater Medical Research Institute equation, which relies on the variables of sex, race/ethnicity, and recorded creatinine levels.[15] Patients were excluded from the study if they received their continuity care primarily from resident physicians or if their mean GFR was less than 20 mL/min.

### Main Outcome Measure

The primary outcome variable was the number of ED visits within the MetroHealth System made by patients over the 2-year study period. Any visit labeled as an ED visit in the encounter data contributed toward the count.

### Independent Variables

We operationalized fragmentation of patient care using a fragmentation of care index (FCI). The FCI is based on a modified version of the previously validated continuity of care index.[16] The continuity of care index, first described by Bice and Boxerman,[17] is based on the number of different providers visited, the proportion of attended visits to each of those providers, and the total number of visits. Our FCI measure used clinics as the unit of measurement, rather than individual providers, and further modified the continuity of care index as follows to compute the FCI:

$$\mathrm{FCI} = \frac{n^2 - \sum_l^k n_k^2}{n(n-1)}$$

where $n$ indicates the total number of visits; $n_k$, the total number of visits to clinic $k$; and $k$, the number of clinics. The FCI can range from 0 (all visits to the same clinic) to 1 (each visit takes place at a different clinic). Visits classified into 1 of the following categories, based on plausible referral specialties for diabetes-related comorbidities or monitoring, were included in the FCI: primary care, cardiology, neurology, endocrinology, ophthalmology, nephrology, urology, pulmonary medicine, podiatry, gastroenterology, and psychiatry.

A practical demonstration of the behavior of the FCI may help in its interpretation. Assume a patient makes 12 visits to the primary care clinic, 1 visit to the ophthalmology clinic, and 2 visits to the podiatry clinic. Her FCI would be 0.36. If the patient's glucose remains poorly controlled, the referring primary care physician might see her more frequently or might decide instead to refer her to the endocrinology clinic. If the patient makes an additional 4 visits to the primary care clinic, the FCI decreases 0.07, from 0.36 to 0.29. If the additional 4 visits instead are to the endocrinology clinic, the dispersion of visits to an additional provider would increase the FCI by 0.21, from 0.36 to 0.57.

### Covariates

Potentially confounding demographic variables used in the analysis included race/ethnicity (black, white, Hispanic, or other), age at the beginning of the study period, sex, and

**Table 1.** Characteristics of the Study Population

| Characteristic | With Diabetes and Chronic Kidney Disease (n = 623) | With Diabetes (N = 3873) | *P* |
|---|---|---|---|
| **Age, mean (95% CI), y** | 68.5 (67.6-69.4) | 58.7 (58.3-59.1) | <.01 |
| **Female sex, No. (%)** | 460 (73.8) | 2503 (64.6) | <.01 |
| **Race/ethnicity, No. (%)** | | | |
| White | 290 (46.5) | 1504 (38.8) | <.01 |
| Black | 274 (44.0) | 1944 (50.2) | |
| Hispanic | 43 (6.9) | 337 (8.7) | |
| Other | 16 (2.6) | 88 (2.3) | |
| **Insurance, No. (%)** | | | |
| Commercial | 102 (16.4) | 1134 (29.3) | <.01 |
| Medicare | 409 (65.7) | 675 (17.4) | |
| Medicaid | 76 (12.2) | 1553 (40.1) | |
| Uninsured | 36 (5.8) | 511 (13.2) | |
| **Comorbidity, No. (%)** | | | |
| Arthritis | 286 (45.9) | 1487 (38.4) | <.01 |
| Coronary artery disease | 180 (28.9) | 653 (16.9) | <.01 |
| Cancer | 186 (29.9) | 1029 (26.6) | .09 |
| Congestive heart failure | 186 (29.9) | 485 (12.5) | <.01 |
| Chronic obstructive pulmonary disease | 63 (10.1) | 279 (7.2) | .01 |
| Cerebrovascular disease | 124 (19.9) | 406 (10.5) | <.01 |
| Hypertension | 589 (94.5) | 3104 (80.1) | <.01 |
| Psychiatric disease | 155 (24.9) | 1091 (28.2) | .09 |
| Total, mean No. (95% CI) | 2.56 (2.46-2.66) | 1.92 (1.88-1.96) | <.01 |
| **Show rate to primary care visits, % (95% CI)** | 86.6 (85.4-87.7) | 82.7 (82.1-83.2) | <.01 |
| **Glycosylated hemoglobin level, mean (95% CI), %** | 7.61 (7.50-7.72) | 7.79 (7.74-7.85) | .01 |
| **Fragmentation of care index (95% CI)** | 0.42 (0.40-0.44) | 0.34 (0.33-0.35) | <.01 |
| **Emergency department visits, No. (95% CI)** | 1.23 (1.07-1.38) | 1.08 (1.01-1.16) | .15 |

CI indicates confidence interval.

insurance status (commercial, Medicaid, Medicare, or uninsured). Potential confounding clinical variables that were adjusted for included severity of diabetes (defined as the mean glycosylated hemoglobin level over the 2-year study period) and a count of comorbidities.[18] Comorbid illnesses and their associated *ICD-9-CM* codes included arthritis (codes 711, 712, 714-716, 720, and 726), coronary artery disease (code 414), cancer (codes 140-239), congestive heart failure (code 428), chronic obstructive pulmonary disease (codes 490-496), hypertension (codes 401-405), liver disease (code 751), stroke (codes 430-438), and psychiatric disease (codes 295-301, 308, 309, and 311). Diabetes and renal disease were not included in the comorbidity count.

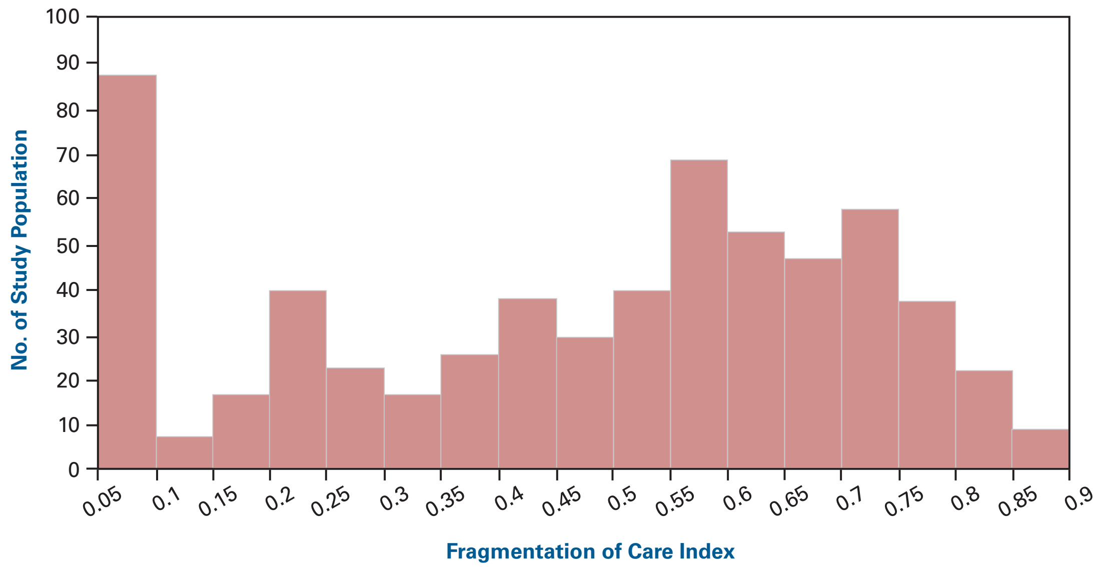
### Statistical Analysis

Frequencies, means, and standard deviations were used to describe the sample population. Negative binomial regression was used to describe the association between the FCI and the number of ED visits, after adjustment for potential confounders. A goodness-of-fit test verified that this model was the most appropriate to the nonrandom overdispersed distribution of ED visit count. The multivariate model was built in a forward stepwise fashion, adjusting for demographic and clinical confounders. Age, sex, race/ethnicity, insurance status, glycosylated hemoglobin level, and number of comorbidities were entered as adjusting variables. Results of the model represent the change in ED visits corresponding to a 0.1-U change in the FCI. For all statistical tests, $P < .05$ was considered statistically significant. We used commercially available statistical software (STATA, version 7.0 for Windows; StataCorp LP, College Station, TX). The protocol was reviewed and approved by the MetroHealth Medical Center Institutional Review Board.

## RESULTS

We identified 3873 patients having diabetes with at least 2 visits to a primary care clinic during the year before the

**Figure.** Distribution of the Fragmentation of Care Index for the Study Population




study period. Of these, 623 patients (16.1%) had chronic kidney disease (Table 1). The mean age of study participants was 68.5 years, 73.8% were female, 46.5% were of white race/ethnicity, and 65.7% were insured by Medicare. The mean glycosylated hemoglobin level was 7.6%, and subjects had a mean of 2.6 comorbidities in addition to diabetes and renal disease. Compared with all patients having diabetes, study subjects with chronic kidney disease were older, more likely to be female, and more likely to be insured by Medicare. Study subjects also had more comorbid conditions, a lower glycosylated hemoglobin level, and a slightly higher show rate to primary care visits.

On average, patients made 19.0 (95% confidence interval [CI], 18.5-20.4) outpatient visits and 1.2 (95% CI, 1.1-1.4) ED visits over the 2-year period. The mean number of ED visits was 1.2 per person (range, 0-16), and almost one-half of study subjects with chronic kidney disease (304 [48.8%]) made at least 1 ED visit. The distribution of the FCI for the study population is shown in the Figure. The mean FCI was 0.42 (median, 0.48), and 14.3% of subjects had an FCI of zero.

To further explore the relationship between the FCI, patient comorbidities, and visit history, we stratified subjects by quintiles of the FCI. The bottom, middle, and highest quintiles of the FCI are compared in Table 2. Subjects in the highest quintile of the FCI had more than twice as many overall visits as those in the lowest quintile (28.51 vs 11.98), with the excess of visits occurring in specialty clinics, notably cardiology, ophthalmology, nephrology, pulmonary, podiatry, and psychiatry. Subjects in the higher quintiles of the FCI also had more comorbid conditions (3.2 and 2.1 for the highest and lowest quintiles, respectively). There were no differences in visit show rates across quintiles of the FCI, suggesting that subjects were able to coordinate their disparate visits fairly well. There was a significant trend toward decreased GFR among higher quintiles of the FCI, although the differences are clinically modest. Other measures of disease severity, including glycosylated hemoglobin level and low-density lipoprotein cholesterol concentration, were similar across FCI values.

In univariate analysis, there was a significant association between the FCI and the number of ED visits. Overall, for each 0.1-U increase in the FCI, there was an 18% increase in the number of ED visits over the 2-year study period (incidence rate ratio [IRR], 1.18; 95% CI, 1.12-1.25). We also evaluated the univariate association between the FCI and the number of ED visits across sex, race/ethnicity, insurance status, and types of comorbidities; we found that the association did not vary significantly across subgroups. After adjustment for age, race/ethnicity, number of comorbidities, show rate to primary care visits, 2-year mean glycosylated hemoglobin level, and insurance status, the FCI remained significantly associated with ED visits (IRR, 1.15; 95% CI, 1.09-1.21; *P* <.01).

## DISCUSSION

This study identifies increased rates of ED use as a possible unintended consequence of care fragmentation among complex patients with diabetes in a continuity primary care setting. Although approximately two-thirds of our patients' visits over the 2-year study period were to their primary care providers, the rest were distributed broadly to seemingly appropriate subspecialty providers, with the 4 most common referrals be-

**Table 2.** Clinical Visits and Comorbidities of Patients With Diabetes and Chronic Kidney Disease by Low, Medium, and High Fragmentation of Care Index (FCI)

| | Quintile of FCI | | | |
|---|---|---|---|---|
| **Characteristic** | **0-20 (n = 129)** | **40-60 (n = 123)** | **80-100 (n = 124)** | ***P*** |
| **FCI, mean** | 0.04 | 0.47 | 0.72 | <.01 |
| **Show rate to all visits, mean %** | 85.45 | 84.71 | 85.42 | .90 |
| **Show rate to primary care visits, mean %** | 86.87 | 86.89 | 87.09 | .99 |
| **No. of visits to clinic, mean** | | | | |
| Primary care | 11.65 | 12.03 | 11.06 | .46 |
| Cardiology | 0.15 | 1.79 | 4.34 | <.01 |
| Endocrinology | 0.00 | 0.31 | 0.68 | <.01 |
| Ophthalmology | 0.11 | 2.67 | 4.10 | <.01 |
| Gastroenterology | 0.00 | 0.09 | 0.60 | <.01 |
| Hepatology | 0.01 | 0.00 | 0.02 | .17 |
| Nephrology | 0.02 | 0.36 | 1.87 | <.01 |
| Neurology | 0.01 | 0.17 | 0.59 | <.01 |
| Podiatry | 0.02 | 0.93 | 2.99 | <.01 |
| Pulmonary | 0.02 | 0.27 | 1.89 | <.01 |
| Urology | 0.00 | 0.00 | 0.03 | .20 |
| Psychiatry | 0.04 | 0.02 | 0.51 | .02 |
| Total, mean No. | 11.98 | 18.55 | 28.51 | <.01 |
| **Comorbidity, mean No.** | 2.05 | 2.43 | 3.17 | <.01 |
| **Glycosylated hemoglobin level, mean %** | 7.46 | 7.72 | 7.54 | .29 |
| **Other laboratory values, mean mg/dL** | | | | |
| Creatinine | 1.41 | 1.48 | 1.64 | <.01 |
| Serum urea nitrogen | 26.78 | 27.29 | 31.72 | .72 |
| Low-density lipoprotein cholesterol | 112.14 | 115.82 | 112.94 | <.01 |
| Glomerular filtration rate | 49.18 | 49.02 | 44.14 | <.01 |

SI conversion factors: To convert creatinine level to micromoles per liter, multiply by 88.4; low-density lipoprotein cholesterol to millimoles per liter, multiply by 0.0259; serum urea nitrogen to millimoles per liter, multiply by 0.357.

ing to ophthalmologists, cardiologists, podiatrists, and nephrologists—specialties often required for disease monitoring or management of diabetic complications.[6] As an "ambulatory care–sensitive" chronic medical condition, proper outpatient care of diabetes should eliminate unnecessary and costly use of the ED.[19-23] In the present investigation, however, after rigorously controlling for various important sociodemographic and clinical characteristics, a 0.1-U increase in the FCI was associated with a 15% increase in the number of ED visits among these patients having diabetes with chronic kidney disease.

Our findings raise concerns about the evidence base for the design of optimal systems of care, as well as the risks and effectiveness of referrals for patients with diabetes. Standards of medical care in diabetes assume the presence of a physician-coordinated healthcare team,[6] although the characteristics of effective teams are unclear.[24] While principles of effective team-based care are embodied in the chronic care model[21] and the primary care medical home,[22,24,25] few data support the effectiveness of these models on quality and utilization of expensive resources such as the ED and in-hospital care. An exception to this is a recent before–after study[25] of a primary care medical home with usual care in a large nonprofit integrated delivery system. In this investigation, ED visits were reduced by 29% in the primary care medical home site compared with control practices, although specialty referrals were more frequent in the primary care medical home site and overall inpatient admissions did not differ between the groups.[25] By contrast, the American Diabetes Association's annual recommendations for needed referrals and comanagement are supplemented by authoritative position statements of other professional organizations and specialty societies,[6,7,15,26] including, for example, recommendations for earlier referral of patients having diabetes with chronic kidney disease.[11,15,27,28] In general, these recommendations are not based on well-conducted and generalizable randomized control trials and reflect a lack of consideration for the unintended consequences of fragmentation of care without adequate coordination. Adherence to guidelines without appropriate attention to the possible adverse effects of fragmentation has widespread implications for the health system, as the diabetes care provided in primary care practices is often poorly integrated with specialist consultants.[29,30] Adherence to referral guidelines may cause undesired confusion to patients, risk patient safety through inadequate communication across specialists, and present challenges to care coordination within the delivery system.[29] Our results suggest that greater involvement of specialists is not without unintended consequences and that it may be appropriate to reexamine the net benefits of referrals, their effect on the continuity of diabetes care, and the need for systems that more effectively coordinate care, especially for patients with chronic and complex medical conditions.[26]

Our findings extend previous work that highlights the association of discontinuity of care with poor glycemic control, patient dissatisfaction, and different providers' confusion regarding their respective roles in patient care among patients with diabetes.[31-34] The FCI described in this study provides a sensitive and quantitative measure of care dispersion that may be increasingly relevant to evaluating care delivery and outcomes, especially for chronic and complex conditions such as diabetes that may warrant team approaches or referrals to multiple medical disciplines.

Nonetheless, we believe that we underestimated the magnitude of actual care fragmentation for several reasons. First, by including as subjects only patients with a documented relationship with their primary care providers, we likely underestimated the severity of illness and the extent of care dispersion in settings and among patients without established continuity relationships. In a recent study on care patterns among representative Medicare beneficiaries by O'Malley and colleagues,[35] for example, more than 50% of patients changed primary provider assignments over a 2-year period, regardless of whether these assignments were identified at the individual provider or group practice level. Second, we included in our FCI only those referral clinics that would be plausibly associated with guidelines-based referrals, omitting care by others such as surgeons or dermatologists, whose care might be indicated for other coexisting (and possibly diabetes-related) problems. In the present study, patients were seen in their primary care settings a mean of 6 times yearly, with care fragmentation defined in association with referrals to diabetes-relevant specialty clinics. Third, we are aware that our care-related data are incomplete and, at least for 1 source of referral care, selectively biased toward underascertainment. For our observational study in a single open healthcare system, study patients were free to seek healthcare services from other providers, including ED care at other facilities. In selecting a subgroup of older patients having diabetes with chronic kidney disease, our subjects were substantially more likely to have healthcare insurance (Table 1), making such out-of-system use more likely than among our broader population of patients with diabetes, more than half of whom were uninsured or insured by state Medicaid programs. Fourth, for patient confidentiality reasons, certain types of psychiatric patient visits are not visible in the electronic medical record, resulting in an underestimate of visits for psychiatric comorbidity, present among approximately 1 in 4 of our subjects. Because the presence of psychiatric comorbidity was associated with an adjusted 40% increased rate of ED visits (data not shown), more complete capture of psychiatric referrals would have not only increased the FCI but also strengthened the relationship between fragmented care and ED use.

We also note the need for caution in interpreting the FCI, as equivalent values of the FCI may represent apparently different arrangements of care. The maximum fragmentation of 19 visits between 2 providers (10 to one provider and 9 to the other) has an FCI of 0.53; this is roughly equivalent to the more moderate fragmentation of our theoretical patient's 19 visits to 4 providers (12 visits to the primary care physician, 1 visit to the podiatrist, 2 visits to the ophthalmologist, and 4 visits to the endocrinologist). In this case, the FCI was 0.57. Future work is needed to elucidate how varying distributions of care with equivalent FCIs are similar or dissimilar with regard to their association with other outcomes.

Other limitations to this investigation should be noted. Perhaps most important, because we did not identify the timing or source of specialist referrals, we are unable to ascribe a causal relationship between fragmented care and ED use. It is plausible that some patients may have been referred to specialty clinics from the ED, resulting in increased fragmentation. We believe that this source of "reverse causality" is unlikely because continuity patients discharged from our ED are routinely given appointments with their primary care providers or practices. In our setting, subspecialty appointments for diabetes-specific monitoring or ongoing comanagement from the ED are exceedingly rare, as might be implied by appointments to ophthalmology, podiatry, or nephrology. We also did not specifically examine other possible explanations for ED care as discussed by Cunningham,[5] such as inadequate inpatient or outpatient capacity in the healthcare system. We are examining these and other hypotheses in an ongoing prospective study. In addition, although we used highly granular measures of disease severity, accounted for comorbid illnesses using validated methods, and adjusted for socioeconomic status, insurance, and race/ethnicity, it is possible that we inadequately accounted for these potential confounders in identifying the strong relationship between fragmented care and ED use. Furthermore, while validated for risk adjustment, some of our measures, such as glycosylated hemoglobin level, are only proxies for disease severity and may be confounded by demographic data. That is, despite rigorous statistical adjustments, it is possible that the observed association of increased fragmented care with ED use was related to unmeasured but increased comorbidity, severity of the underlying diabetes, or some other undefined underlying propensity for the patient to seek or be referred to healthcare in general. As summarized in Table 2, however, there were virtually no clinically meaningful differences in various severity measures across the lowest to highest quintiles of the FCI, including glycosylated hemoglobin level, low-density lipoprotein cholesterol concentration, and estimated GFR. Likewise, the unadjusted effect of the FCI on ED use was significant and consistent across virtually all comorbid illnesses. Although the principal diagnosis at the time of an ED visit was not available in the electronic medical record, we have no reason to believe that the distribution of visits for nondiabetic causes (such as trauma) was biased toward those with higher FCI values, thus warranting statistical adjustment, but we were unable to confirm this given our data. Finally, the generalizability of our study is limited because of its setting in 1 urban healthcare system and its mature use of electronic medical records for patient care. In particular, whether the availability to all providers of a common electronic record system[36] may have minimized the adverse effects of care fragmentation, as suggested by others,[35,37-39] is unknown.

In conclusion, the results of our investigation suggest that the posited benefits of specialist referrals among complex patients with diabetes may be partially negated by care fragmentation. Future research should target the development of better models for care coordination and further evaluate the marginal benefits of referrals.

*Acknowledgments*

We thank Andrew O'Connor, DO, MPH, for input into study design and to David C. Aron, MD, MS, for his thoughtful review of the manuscript.

***Author Affiliations:*** From Case Western Reserve University (CWL, DE, RDC), Cleveland, OH; and the Center for Health Care Research and Policy (DE, RDC) and the Departments of Medicine, Epidemiology, and Biostatistics (DE, RDC), MetroHealth Medical Center, Cleveland, OH.

***Funding Source:*** This study was supported in part by grants T32- HS00059 (CWL) and R01-HS015123 (RDC).

***Author Disclosures:*** The authors (CWL, DE, RDC) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

***Authorship Information:*** Concept and design (CWL, DE, RDC); acquisition of data (CWL, DE, RDC); analysis and interpretation of data (CWL, DE, RDC); drafting of the manuscript (CWL, DE, RDC); critical revision of the manuscript for important intellectual content (CWL, DE, RDC); statistical analysis (CWL, RDC); provision of study materials or patients (DE, RDC); obtaining funding (RDC); administrative, technical, or logistic support (DE, RDC); and supervision (DE, RDC).

***Address correspondence to:*** Constance W. Liu, MD, PhD, Case Western Reserve University, 2383 Overlook Rd, Cleveland, OH 44016. E-mail: constance.liu@case.edu.

## REFERENCES

**1. Starfield B.** Promoting equity in health through research and understanding. *Dev World Bioeth.* 2004;4(1):76-95.

**2. Hogan P, Dall T, Nikolov P; American Diabetes Association.** Economic costs of diabetes in the US in 2002. *Diabetes Care.* 2003;26(3): 917-932.

**3. Saaddine JB, Engelgau MM, Beckles GL, Gregg EW, Thompson TJ, Narayan KMV.** A diabetes report card for the United States: quality of care in the 1990s. *Ann Intern Med.* 2002;136(8):565-574.

**4. Hicks LS, O'Malley AJ, Lieu TA, et al.** The quality of chronic disease care in U.S. community health centers. *Health Aff (Millwood).* 2006;25(6):1712-1723.

**5. Cunningham PJ.** What accounts for differences in the use of hospital emergency departments across U.S. communities? *Health Aff (Millwood).* 2006;25(5):w324-w336.

**6. American Diabetes Association.** Standards of medical care in diabetes: 2007. *Diabetes Care.* 2007;30(suppl 1):S4-S41.

**7. Nephrology Service WRAMC.** Referral Guidelines for Nephrology. Web page. 5/27/2010; Referral Guide. http://www.wramc.army.mil/Patients/healthcare/medicine/endocrinology/Pages/referral.aspx. Accessed May 27, 2010.

**8. Zhang Q, Safford M, Ottenweller J, et al.** Performance status of health care facilities changes with risk adjustment of HbA1c. *Diabetes Care.* 2000;23(7):919-927.

**9. Harris MI.** Health care and health status and outcomes for patients with type 2 diabetes. *Diabetes Care.* 2000;23(6):754-758.

**10. Skelly AH, Arcury TA, Gesler WM, et al.** Sociospatial knowledge networks: appraising community as place. *Res Nurs Health.* 2002;25(2):159-170.

**11. Kemper P, Blumenthal D, Corrigan JM, et al.** The design of the Community Tracking Study: a longitudinal study of health system change and its effects on people. *Inquiry.* 1996;33(2):195-206.

**12. Sia C, Tonniges TF, Osterhus E, Taba S.** History of the medical home concept. *Pediatrics.* 2004;113(5 suppl):1473-1478.

**13. Sanderson C, Dixon J.** Conditions for which onset or hospital admission is potentially preventable by timely and effective ambulatory care. *J Health Serv Res Policy.* 2000;5(4):222-230.

**14. American Diabetes Association.** Standards of medical care for patients with diabetes mellitus. *Diabetes Care.* 2002;33(5):S33-S49.

**15. National Kidney Foundation.** K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Am J Kidney Dis.* 2002;39(2 suppl 1):S1-S266.

**16. Saultz JW.** Defining and measuring interpersonal continuity of care. *Ann Fam Med.* 2003;1(3):134-143.

**17. Bice TW, Boxerman SB.** A quantitative measure of continuity of care. *Med Care.* 1977;15(4):347-349.

**18. Perkins AJ, Kroenke K, Unützer J, et al.** Common comorbidity scales were similar in their ability to predict health care costs and mortality. *J Clin Epidemiol.* 2004;57(10):1040-1048.

**19. Rutstein DD, Berenberg W, Chalmers TC, Child CG III, Fishman AP, Perrin EB.** Measuring the quality of medical care: a clinical method. *N Engl J Med.* 1976;294(11):582-588.

**20. Weissman JS, Gatsonis C, Epstein AM.** Rates of avoidable hospitalization by insurance status in Massachusetts and Maryland. *JAMA.* 1992;268(17):2388-2394.

**21. Roos LL, Walld R, Uhanova J, Bond R.** Physician visits, hospitalizations, and socioeconomic status: ambulatory care sensitive conditions in a Canadian setting. *Health Serv Res.* 2005;40(4):1167-1185.

**22. Weingarten N, Meyer DL, Schneid JA.** Failed appointments in residency practices: who misses them and what providers are most affected? *J Am Board Fam Pract.* 1997;10(6):407-411.

**23. Billings J, Anderson GM, Newman LS.** Recent findings on preventable hospitalizations. *Health Aff (Millwood).* 1996;15(3):239-249.

**24. Shojania KG, Ranji SR, McDonald KM, et al.** Effects of quality improvement strategies for type 2 diabetes on glycemic control: a meta-regression analysis. *JAMA.* 2006;296(4):427-440.

**25. Reid RJ, Fishman PA, Yu O, et al.** Patient-centered medical home demonstration: a prospective, quasi-experimental, before and after evaluation. *Am J Manag Care.* 2009;15(9):e71-e87.

**26. Clark MJ Jr, Sterrett J, Carson DS.** Diabetes guidelines: a summary and comparison of the recommendations of the American Diabetes Association, Veterans Health Administration, and American Association of Clinical Endocrinologists. *Clin Ther.* 2000;22(8):898-910.

**27. Jungers P, Zingraff JJ, Albouze G, et al.** Late referral to maintenance dialysis: detrimental consequences. *Nephrol Dial Transplant.* 1993;8(10):1089-1093.

**28. Locatelli F, Vecchio LD, Pozzoni P.** The importance of early detection of chronic kidney disease. *Nephrol Dial Transplant.* 2002;17(suppl 11):2-7.

**29. Flauto RP, Leon JB, Sehgal AR.** The provision and outcomes of diabetic care of hemodialysis patients. *Am J Kidney Dis.* 2003;41(1):125-131.

**30. Beaulieu ND, Cutler D, Ho K, Horrigan D, Isham G.** *The Business Case for Diabetes Disease Management at Two Managed Care Organizations: A Case Study of HealthPartners and Independent Health Association.* New York, NY: Commonwealth Fund; 2003. Field report 610. http://www.cmwf.org. Accessed April 30, 2010.

**31. Desai S, Jessup M.** Practice guidelines: role of internists and primary care physicians. *Med Clin North Am.* 2004;88(5):1369-1380, xiii.

**32. O'Connor PJ, Desai J, Rush WA, Cherney LM, Solberg LI, Bishop DB.** Is having a regular provider of diabetes care related to intensity of care and glycemic control? *J Fam Pract.* 1998;47(4):290-297.

**33. Saultz JW, Albedaiwi W.** Interpersonal continuity of care and patient satisfaction: a critical review. *Ann Fam Med.* 2004;2(5):445-451.

**34. Saultz JW, Lochner J.** Interpersonal continuity of care and care outcomes: a critical review. *Ann Fam Med.* 2005;3(2):159-166.

**35. O'Malley AS, Grossman JM, Cohen GR, Kemper NM, Pham HH.** Are electronic medical records helpful for care coordination? Experiences of physician practices. *J Gen Intern Med.* 2010;25(3):177-185.

**36. DesRoches CM, Campbell EG, Rao SR, et al.** Electronic health records in ambulatory care: a national survey of physicians. *N Engl J Med.* 2008;359(1):50-60.

**37. Jaén CR, Stange KC, Nutting PA.** Competing demands of primary care: a model for the delivery of clinical preventive services. *J Fam Pract.* 1994;38(2):166-171.

**38. Elder NC, Hickner J.** Missing clinical information: the system is down. *JAMA.* 2005;293(5):617-619.

**39. Burton LC, Anderson GF, Kues IW.** Using electronic health records to help coordinate care. *Milbank Q.* 2004;82(3):457-481. ■