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Relationship between Continuity of Ambulatory Care and Risk of Emergency Department Episodes among Older Adults

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Abstract

OBJECTIVE—To determine whether visit patterns indicative of higher continuity are related to a lower risk of presenting at the emergency department (ED) among older adults.

METHODS—Survival analysis between 2011 and 2013 of a 20% random sample of fee-for-service Medicare beneficiaries at least 66 years old. Ambulatory visit patterns were measured starting in 2011 for up to 24 months using 2 continuity metrics measured on a 0-1 scale—continuity of care (COC) score and usual provider continuity (UPC) score. The composite outcome of an ED episode was defined as occurrence of an ED visit with discharge home, an observation stay, or hospital admission. Time-dependent Cox proportional hazards regression models controlled for patient demographic characteristics, comorbidities, prior utilization, and regional factors, with censoring for death or occurrence of the composite outcome. In a secondary analysis, continuity was measured in the 12 months preceding an ED episode to test whether it was associated with type of ED episode.

RESULTS—The relative rate of ED episodes decreased about 1% for every 0.1 increase in the COC score (adjusted HR 0.99, 95% CI 0.99–0.99; $P < 0.0001$) and 2% for every 0.1 increase in the UPC score (adjusted HR 0.98, 95% CI 0.98–0.99; $P < 0.0001$), or up to a 10% lower rate between the lowest and highest COC score and a 20% lower rate for the UPC score. Among beneficiaries with an ED episode, higher continuity was associated with a 1-2% lower risk of observation stay but a 3% higher risk of hospital admission relative to an ED visit with discharge home.

CONCLUSIONS—Ambulatory visit patterns exhibiting more continuity were associated with a lower rate of ED utilization for older adults with fee-for-service Medicare coverage. The association of higher continuity with lower risk of ED use but differences in outcome when an ED visit does occur may reflect more appropriate referral to the ED when outpatient management is no longer adequate.

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Introduction

Background

Fifteen percent of all emergency department (ED) visits and 40% of emergent hospitalizations in the United States are for patients 65 years of age or older.¹ Reasons that older adults visit the ED vary from experiencing a health problem that demands immediate attention to having difficulty accessing ambulatory care.^{2,3} Although addressing a health need is the most common and pressing reason older adults visit the ED, factors related to access to or their experience of care may also be related to their use of the ED. For example, the presence of a usual care physician has been shown to lower an older adult's risk of visiting the ED.⁴

Three main treatment patterns are possible when older adults present at an ED—they can be released, kept for an observation stay of shorter than 48 hours, or admitted to the hospital for further treatment. Decisions around these treatment patterns have been studied in acute cardiac disease but less so in other conditions.^{5,6} Severity of the presenting condition certainly contributes to which of these treatment patterns a patient experiences, but other factors may also be important. If a patient is being closely managed by an ambulatory care physician, the patient may only present at the ED for a serious issue necessitating hospitalization. Likewise, an observation stay or admission may not be necessary if a patient can clearly identify a physician who manages his or her care in the ambulatory setting. As a result, continuity of ambulatory care may influence whether a patient presents at the ED and the ensuing treatment pattern of the ED episode.

Importance

The fee-for-service Medicare program provides health care coverage for most older adults in the United States. Medicare patients can visit any physician willing to see them, and physicians can refer patients without network restrictions, with the typical Medicare patient experiencing 8 visits with 4 different physicians annually.⁷ The pattern of visits provides insight into a patient's care,⁸ with a visit pattern concentrated around a physician or small number of physicians suggesting more continuity in contrast to a pattern diffused across several different physicians, which suggests greater fragmentation. Evidence from the visit patterns of older adults in Canada as well as commercially insured children and Medicaid patients in the United States suggests that a high level of continuity is related to less ED utilization, but older adults in fee-for-service Medicare has not been studied.⁹⁻¹¹

Goals of This Investigation

We expected that older adults with higher continuity of ambulatory visits would have a lower rate of ED utilization. We analyzed claims data from a large, national sample of fee-for-service Medicare beneficiaries to study whether the continuity of visits for older adults, using two different metrics of continuity, had any relationship with the occurrence of an ED episode. We then examined if continuity was related to whether a patient has an observation stay or hospital admission compared to being discharged home from the ED.

Methods

Study Design

This study uses a survival analysis of Medicare patients' ambulatory visit patterns starting in 2011 for up to 24 months. Patients were followed for 24 months or until death or occurrence of the composite endpoint of an ED episode—that is, an ED visit followed by discharge, an observation stay, or a hospital admission through the ED. Since secondary, de-identified data were used, this study was exempt from IRB approval in accordance with Federal common rule (section 45 CFR 46.101[b][5]).

Selection of Participants

Continuously enrolled fee-for-service Medicare beneficiaries 66 years of age or older by the end of 2011 from a 20% random sample were identified in the Master Beneficiary Summary File in the Chronic Conditions Warehouse.¹² Medicare Advantage beneficiaries were excluded because their claims data are not available to researchers. Beneficiaries with fewer than 4 ambulatory evaluation and management visits in 2011 were also excluded because continuity metrics can too easily reach their maximum or minimum values of 0 or 1 with few visits, which would create bias in the results.¹³ Approximately 30% of the otherwise eligible population were excluded on this basis (characteristics shown in Web Appendix 1).

Methods and Measurements

Ambulatory visits in Medicare are billed in the Carrier file or, for a small minority of providers who work at Federally Qualified Health Centers (FQHCs) or Rural Health Centers (RHCs), in the hospital outpatient file. In the Carrier file, ambulatory evaluation and management (E&M) codes billed by primary care and specialist physicians, as identified by the specialty code on the claim, were included in the measurement of continuity (E&M codes in Web Appendix 2). In the hospital outpatient file, visits at FQHCs or RHCs were identified by the facility type 7 and service classification type of either 3 or 1. For these visits, which constituted less than 2% of the total visits used to measure continuity, there is no unique identifier for provider specialty, so visits to each unique center were effectively considered visits to the same physician.

Two continuity metrics were used—the Continuity of Care (COC) score and the Usual Provider Continuity (UPC) score.^{15,16} The COC score was the primary continuity metric because it uses total number of visits, total number of physicians, and number of visits with each physician to measure the dispersion of a patient's total visit pattern. The UPC score was used as a secondary metric because it captures the concentration of visits to a single physician but does not account for the dispersion of visits across all physicians in a patient's visit pattern (illustration in Web Appendix 2).

Outcomes

The main outcome was the occurrence of an ED episode, which was a composite outcome defined as an ED visit and discharge, observation stay through the ED, or hospital admission through the ED. Each of the three types of ED episodes was identified separately in claims data. ED visits that result in discharge (treat-and-release) are recorded in outpatient revenue

center claims, and emergent hospitalizations are in inpatient revenue center claims (codes 0450-0459 or 0981); observation stays are recorded in either outpatient or inpatient revenue center claims (code 0762).¹⁴ Any ED episode with a trauma ICD-9 diagnosis code (959) was excluded because occurrence of trauma is unlikely related to a patient's ambulatory care.¹⁷

Analysis

After a patient had 4 visits in 2011, he or she was observed for up to 24 months. Each continuity score was measured until the patient presented at an ED, died, or at the end of his or her 24-month observation period in 2013, whichever occurred first. The COC score and UPC score are measured on a scale from 0 (lowest continuity) to 1 (highest continuity); their values were multiplied by 10 in the statistical models so that the regression results could be interpreted relative to 0.1-unit, or 10%, intervals.

Time-dependent Cox proportional hazards regression was used to perform the survival analysis.¹⁸ We used survival analysis because it censors a patient from further observation once an ED episode occurs and avoids the confounding that could occur with measuring continuity throughout the time a patient could experience multiple ED episodes. As exposure time increases, continuity changes as visits accumulate, which necessitated treating continuity as a time-dependent variable. The continuity scores were cumulatively measured monthly from the fourth visit while staying the same if a patient had no visits in a given month. The time-dependent Cox model reads each observation distinctly each month, thereby avoiding temporal autocorrelation.¹⁹ Separate models were run for COC and UPC measures, with the outcome being the composite ED episode. Less than 1% of the beneficiaries had missing values and were dropped from the multivariate analyses.

As a secondary analysis among beneficiaries with an ED episode, we tested whether continuity was associated with the type of ED episode to provide insights into how continuity of care might be related to different treatment patterns once a patient presents at the ED. The COC and UPC were measured over the 12 months preceding the ED episode. Multinomial logistic regression was used to estimate the relative risk of an observation stay or emergent hospitalization relative to an ED visit alone.

Several additional variables were used in the analyses to control for factors that may be related to continuity of care or ED utilization. Demographic and enrollment characteristics were gleaned from the Master Beneficiary Summary File. Beneficiary age was a discrete variable and represented the beneficiary's age at the end of 2011. Sex was coded as female versus male. Race and ethnicity was coded as non-Hispanic white, black, Hispanic, Asian, or other. Beneficiaries whose Medicare coverage preceded turning age 65 were considered disabled. Those who were Medicaid dual-eligible any month between 2011 and 2013 were deemed dual-eligible beneficiaries.

Patient illness burden at baseline was accounted for in more than one way. First, each patient's 2011 Hierarchical Condition Category (HCC) score was included in the models, as the HCC score is a numerical value specifically developed for Medicare patients to capture expected resource use based on a patient's clinical profile in the previous year (2010).¹⁹ HCC scores were divided into quartiles based on their data distribution. In addition, since

sicker patients tend to need more medical care, the total number of ambulatory evaluation and management visits and total number of ED episodes in the 12 months prior to the start of a patient's study observation period were included as two distinct variables in the Cox models.

For the secondary analysis, the same covariates from the main analysis were included in the model, although some modifications were necessary to control for illness burden since this analysis was not time-dependent. First, total ambulatory evaluation and management visits were measured during the 12 months prior to the ED episode. Second, since hospitalization in the prior 30 days is a risk factor for ED utilization,^{20,21} an indicator variable marked whether a hospitalization occurred in the month prior to the ED episode. Finally, another indicator variable was added for whether the ED episode began on the weekend (Saturday or Sunday), which may influence whether a patient is discharged home from the ED, observed through the ED, or admitted through the ED.

Finally, hospital referral region (HRR) fixed effects were used to account for any time-invariant geographic factors such as ED availability or hospital bed capacity that could affect the relationship between continuity and ED utilization.

In sensitivity analyses, the COC score and UPC score were each run with mortality as an outcome in bivariate Cox proportional hazards regression models to determine whether the censoring of deceased patients might confound the main results by leaving healthier patients in the analysis. Models were also run using lagged COC score or UPC score values 1, 3, 6, or 12 months, rather than the value for the immediately preceding month. For a 1-month lag, analyses were restricted to beneficiaries with study observation periods of up to 23 months, with a 3-month lag requiring up to 21 months, a 6-month lag requiring up to 18 months, and a 12-month lag requiring up to 12 months.

Analyses were conducted using SAS-EG version 7.1, with the Efron option used in the Cox proportional hazards regression models to adjust for tied events.

Results

Characteristics of Study Subjects

The total number of fee-for-service Medicare beneficiaries meeting eligibility criteria in the 20% sample was 4,605,633, and 1,405,475 (30.5%) were excluded because they did not have at least 4 ambulatory evaluation and management visits in 2011 (Web Appendix 2). The excluded group of beneficiaries appeared to be healthier, as they tended to be slightly younger with a lower median HCC score and fewer ED episodes between 2011 and 2013.

The final study population included 3,200,158 fee-for-service Medicare beneficiaries. Almost 60% of the study population experienced an ED episode between 2011 and 2013 (Table 1). Patients with an ED episode were more often women, older, black or Hispanic, Medicaid dual-eligible, originally enrolled in Medicare as disabled, and sicker, as measured both by higher HCC scores and more visits and hospitalizations. The majority of ED episodes were ED visits alone (54.8%), followed by hospital admissions through the ED

(32.2%) and then observation stays through the ED (13.0%) (Table 2). A higher proportion of women had an ED visit and discharge than an observation stay or admission. Patients with ED visits alone also had lower illness burden according to HCC scores compared with those with an observation stay or admission. Those who were admitted tended to be older and more likely to be Medicaid dual-eligible or disabled.

Over time, unadjusted mean values of the continuity scores measured at 3-month intervals decreased, and the difference in means grew between beneficiaries with and without an ED episode for both COC scores (0.013 to 0.024) and UPC scores (0.012 to 0.026) (Figure 1).

Main Results

In bivariate models, the ED episode rate decreased 1% for every 0.1 increase in the COC score and 2% for every 0.1 increase in the UPC score; results were unchanged in multivariate analyses (COC score adjusted HR 0.99, 95% CI 0.99—0.99, $P < 0.0001$; UPC score adjusted HR 0.98, 95% CI 0.98—0.99, $P < 0.0001$) (Table 4). For both the COC score model and UPC score model, women, black or Hispanic patients, Medicaid dual-eligible patients, the disabled, and those with greater illness burden according to the HCC score were slightly more likely to have an ED episode.

In analyses restricted to patients with an ED episode, an observation stay was 1-2% less likely than an emergency visit for every 0.1 increase in a continuity score (COC score adjusted OR 0.99, 95% CI 0.98—0.99; UPC score adjusted OR 0.98, 95% CI 0.98—0.99), while an admission was 3% more likely than an ED visit alone (COC score adjusted OR 1.03, 95% CI 1.03—1.03, UPC score adjusted OR 1.03, 95% CI 1.03—1.04). HCC score and a hospitalization in the prior month were associated with greater likelihood of an observation stay and admission. Patients in the most severe quartile of the HCC score distribution had as much as an 13% higher risk of observation stay and 71% higher risk of emergent hospitalization compared with patients with an ED visit alone, while patients with a prior hospitalization were about 12% more likely to have an observation stay and about 80% more likely to have a hospitalization through the ED. An observation stay was about 34% less likely on the weekend than an ED visit alone, while an ED admission was no more or less likely.

In the sensitivity analysis with mortality as an outcome, the hazard for each model was null, showing that the main results are not confounded by censoring decedents. Using lagged continuity scores, the ED episode rate did not change the association of ED episodes with the COC score or UPC score in adjusted models (Web Appendix 2-3).

Limitations

Continuity was measured on the basis of ambulatory evaluation and management visits with physicians, which produced a conservative count of the number of office visits with providers that contribute to a patient's actual continuity since nurse practitioners and other clinicians were excluded. Approximately 30% of the fee-for-service Medicare beneficiaries had fewer than 4 such visits overall and were eliminated from the analyses to avoid including patients with spuriously high or low continuity scores. These patients tended to be healthier than their counterparts or may have had a low number of visits because they had

additional contact with providers beyond office visits alone. We are unable to comment on the role of continuity for these low-utilizing individuals. Whether low continuity is being driven by patient choice or physician referral may also be important to consider, as claims data are not able to distinguish these two influences on visit patterns. Another limitation of the data is that visits at RHCs and FQHCs had to be counted as visits to the same physician, which may artificially inflate continuity scores, but at less than 2% of total visits, they would have a small influence and any bias would be toward the null. Additionally, we did not control for factors such as marital status or educational level that have been shown to be related to ED utilization in older adults because these data are not available from Medicare claims or enrollment data.^{3,22} These factors, however, have a relatively weak relationship with the outcome of interest compared with illness burden and the geographical supply of health care resources,²³ which were controlled for in our analyses. Finally, this study uses observational methods and so cannot assert a causal relationship between the continuity of ambulatory care and ED episode rate.

DISCUSSION

Continuity of care was defined in our analyses as the degree to which a patient's visit pattern is concentrated among physicians. It was measured up to 24 months according to 2 metrics, one that measures the concentration of visits to a single physician and one that takes into account the number of visits a patient made to each physician across all physicians in the patient's ambulatory visit pattern, controlling for demographic characteristics such as Medicaid coverage and disability known to be related to ED use as well as baseline utilization patterns.^{24,25} We found that higher continuity of ambulatory visits was associated with a lower risk of an ED episode, although among those with an ED episode, higher continuity was related to a higher risk of hospitalization through the ED. The magnitude of the findings were such that the relative risk of an ED episode could be up to 10% lower for patients with the highest, compared with the lowest, COC score and, similarly, up to 20% lower for patients according to the UPC score.

Despite the differences in methods and patient populations, our study confirms and builds on previous research that has found a protective relationship between continuity of care and ED episodes and hospital utilization. Christakis and colleagues tested the COC score with the likelihood of an ED visit for Medicaid and non-Medicaid pediatric patients.^{10,26} They tracked patients' visit patterns at an outpatient clinic over 4 years, and in two separate studies, higher continuity was associated with lower risk of both ED visits and hospitalizations. Gill and colleagues examined the visit patterns of Medicaid patients up to 64 years of age over the course of a year and found a lower rate of single or multiple ED visits for those with higher levels of continuity.¹¹ Wasson and colleagues randomized male veterans to "continuity" and "discontinuity" groups and then measured their resource use and visit patterns using the COC score.²⁷ The COC score was significantly higher for the continuity group, which experienced significantly fewer emergent hospitalizations. Additionally, the same approach to measuring continuity used in this study showed that higher continuity was related to a lower rate of preventable hospitalization for fee-for-service Medicare beneficiaries, but ED episodes had not previously been studied in this population.²⁸

The main factors associated with ED utilization among older adults are a perceived need for care and difficulty accessing ambulatory care.³ Ironically, our study suggests that after controlling for their underlying illness burden, older adults who see more physicians and have more visits in ambulatory care—that is, lower continuity—are at greater risk for visiting the ED. Conversely, older adults whose visit pattern is concentrated around fewer physicians—or higher continuity—are at lower risk. Thus, access to ambulatory care alone appears to be insufficient for reducing ED use. Medicare patients who frequently access ambulatory care across several different physicians may lack enough consistency with a usual care physician or small group of clinicians to have a clear source for first-contact or follow-up care. It is also possible that the low continuity of a diffuse visit pattern reflects dissatisfaction with or perceived access barriers to a usual source of care, prompting presentation at the ED.²⁹

At the same time, among patients with an ED episode, those with higher continuity were at higher risk of admission but lower risk of observation stay relative to their peers who merely visited the ED and were released. In other words, higher continuity was associated with lower risk of having any ED episode, but when one occurred, the patient was more likely to be hospitalized.

The reasons for this relationship cannot be fully ascertained from claims data. One possible explanation is that the availability of an ambulatory care physician familiar enough with the patient to follow up after ED discharge may affect the ED physician's decision to release or keep the patient for an observation stay. Higher continuity may be associated with inpatient admission when an ED episode occurs because the patient may have a usual care physician who provides clearer guidance on which situations are serious enough to warrant an ED visit as opposed to waiting for a clinic visit or who refers to the ED because the capabilities of outpatient management have been exhausted. Without further study, however, it would be difficult to assert any of these interpretations based on claims data alone. A future area for investigation is whether certain clinical or demographic subgroups are more likely to experience low continuity and its adverse effects.

Regardless of whether an office visit is initiated by a patient or at the recommendation of a physician, making multiple visits across many distinct physicians lowers a patient's continuity of care and may expose patients to a higher risk of presenting at an ED. Continuity alone does not signify anything about the content of the care that patients receive, but in theory, higher continuity in visit patterns provides more opportunities to foster longitudinal patient-physician relationships and fewer chances for poor hand-offs of patient care between physicians, thereby lessening the risk of duplicated care, disoriented patients, and deleterious effects on patient health. The findings from this study suggest that encouraging older adults in fee-for-service Medicare to see a usual care physician could be a mechanism to deter utilization of the ED.

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Appendix

Web Appendix 1

Characteristics of Beneficiaries Included and Excluded from the Study.

	Four or More Visits in 2011 (Included)	Fewer than Four Visits in 2011 (Excluded)
N (%)	3,200,158 (69.5)	1,405,475 (30.5)
Female, %	58.7	56.8
Age, mean yrs.	76.8	75.4
Race/ethnicity, %		
Non-Hispanic white	84.8	82.8
Black	6.7	7.6
Hispanic	4.6	5.0
Asian	2.5	2.5
Other	1.2	2.1
Medicaid dual eligible, %	15.5	18.2
Original coverage from disability, %	8.8	7.0
HCC score, median (IQR)	1.3 (1.0-1.8)	1.1 (0.9-1.3)
Visit patterns 2011-13, median (IQR)		
COC score	0.258 (0.17-0.42)	0.333 (0.19-0.78)
UPC score	0.467 (0.33-0.63)	0.667 (0.50-1.0)
Total visits	14 (8-21)	4 (2-7)
Total physicians	13 (8-21)	4 (1-6)
ED episode 2011-13, %	59.8	46.9
Emergency visit	32.8	26.5
Observation stay	7.8	5.0
Admission through the ED	19.2	15.3

NOTE: Continuously enrolled Medicare fee-for-service beneficiaries were at least 66 years of age and had 4 or more or fewer than 4 ambulatory evaluation and management visits in 2011 and were followed up to 24 months until death or first emergency department (ED) episode, if one occurred. An emergency department (ED) episode is an ED visit and discharge, observation stay through the ED, or admission through the ED. Visit patterns and ED episodes from 2011-13 were not calculated over the same number of months for all beneficiaries. Hierarchical Condition Category (HCC) score was calculated from utilization in 2010. IQR is interquartile range.

Web Appendix 2

Evaluation and Management Codes and COC Score and UPC Score Formulas and Values for Hypothetical Visit Patterns.

	Physician A	Physician B	Physician C	Physician D	Physician E	Physician F	Physician G	Physician H	COC Score	UPC Score
Patient A	8	0	0	0	0	0	0	0	1.000	1.000
Patient B	7	1	0	0	0	0	0	0	0.750	0.875
Patient C	6	2	0	0	0	0	0	0	0.571	0.750
Patient D	6	1	1	0	0	0	0	0	0.536	0.750
Patient E	5	3	0	0	0	0	0	0	0.464	0.625
Patient F	4	4	0	0	0	0	0	0	0.429	0.500
Patient G	5	2	1	0	0	0	0	0	0.393	0.625
Patient H	5	1	1	1	0	0	0	0	0.357	0.625
Patient I	4	3	1	0	0	0	0	0	0.321	0.500
Patient J	4	2	1	1	0	0	0	0	0.250	0.500
Patient K	4	1	1	1	1	0	0	0	0.214	0.500
Patient L	3	2	1	1	1	0	0	0	0.143	0.375
Patient M	3	1	1	1	1	1	0	0	0.107	0.375
Patient N	2	1	1	1	1	1	1	0	0.036	0.250
Patient O	1	1	1	1	1	1	1	1	0.000	0.125

NOTE: Continuity of care (COC) score and usual provider continuity (UPC) score formulas and values shown for different visit patterns. Numbers denote the number of visits with each physician for a total number of visits held constant at 8 for all patients.

Evaluation and management ambulatory visit codes in the Carrier (Part B) claims: 90801-90815; 90862; 90791-90792; 90832-90838; 99201-99205; 99211-99215; 99241-99245; 99341-99345; 99347-99350; 99354-99355; 99381-99397; 99401-99409; 99411-99412; 99420; 99429

COC score: $\text{COC score} = (\sum n_i^2 - N) / N(N - 1)$, where n_i = number of visits that the patient has with the i^{th} physician and N = total visits

UPC score: n / N , where n = number of visits with the physician with whom the patient has the most visits and N = total visits

Web Appendix 3

COC Score and Lagged Analyses.

	No Lag	1 Month	3 Months	6 Months	12 Months
N	3,200,129	2,994,842	2,732,567	2,439,983	2,009,506
Unadjusted					
Continuity	0.99 (0.99—0.99)	0.98 (0.98—0.99)	0.98 (0.98—0.98)	0.98 (0.98—0.98)	0.98 (0.98—0.98)
Adjusted					
Continuity	0.99 (0.99—0.99)	0.99 (0.99—0.99)	0.99 (0.99—0.99)	0.99 (0.99—0.99)	0.99 (0.99—0.99)
Female	1.05 (1.04—1.05)	1.05 (1.04—1.05)	1.05 (1.04—1.05)	1.05 (1.04—1.05)	1.05 (1.05—1.06)
Age	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.01 (1.01—1.01)
Race/ethnicity					
Non-Hispanic white	1.0	1.0	1.0	1.0	1.0
Black	1.04 (1.03—1.04)	1.04 (1.03—1.05)	1.04 (1.04—1.05)	1.04 (1.04—1.05)	1.05 (1.04—1.06)
Hispanic	1.02 (1.02—1.03)	1.01 (1.00—1.02)	1.01 (1.00—1.01)	1.00 (0.99—1.01)	0.99 (0.98—1.00)
Asian	0.94 (0.93—0.95)	0.92 (0.91—0.93)	0.91 (0.90—0.92)	0.90 (0.89—0.91)	0.85 (0.84—0.87)
Other	0.97 (0.96—0.98)	0.96 (0.94—0.97)	0.95 (0.94—0.97)	0.94 (0.93—0.96)	0.92 (0.90—0.94)
Medicaid dual eligible	1.02 (1.02—1.03)	1.02 (1.01—1.02)	1.02 (1.01—1.02)	1.02 (1.01—1.02)	1.03 (1.02—1.04)
Original coverage from disability	1.03 (1.03—1.04)	1.04 (1.03—1.04)	1.05 (1.04—1.05)	1.05 (1.05—1.06)	1.09 (1.08—1.10)
HCC score					
Low	1.0	1.0	1.0	1.0	1.0
Mild	1.03 (1.02—1.03)	1.03 (1.03—1.03)	1.03 (1.03—1.04)	1.04 (1.03—1.04)	1.05 (1.04—1.05)
Moderate	1.05 (1.04—1.05)	1.05 (1.05—1.06)	1.06 (1.05—1.06)	1.07 (1.06—1.07)	1.09 (1.08—1.10)
Severe	1.02 (1.02—1.03)	1.03 (1.02—1.03)	1.04 (1.03—1.04)	1.05 (1.04—1.06)	1.11 (1.10—1.11)
Total visits in prior 12 months	1.01 (1.01—1.01)	1.01 (1.01—1.01)	1.01 (1.01—1.01)	1.01 (1.01—1.01)	1.01 (1.01—1.01)
Total ED episodes in prior 12 months	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.01 (1.01—1.01)	1.02 (1.02—1.02)

NOTE: Analyses include continuously enrolled fee-for-service Medicare beneficiaries 66 years of age or older with at least 4 visits in 2011 until death or ED episode, defined as an ED visit and discharge, observation stay through the ED, or admission through the ED. Continuity of Care (COC) score values are lagged 1, 3, 6, or 12 months and change each month that a beneficiary has an ambulatory evaluation and management visit or held constant. Beneficiaries were restricted to those with a minimum number of observation months. COC score 0.1-unit changes indicate the amount of change in hazard ratio. Total visits are the total number of ambulatory evaluation and management visits per patient and ED episodes are the total number of ED episodes per patient during the 12 months preceding a beneficiary's observation period in the study. All statistically significant results are $P < 0.0001$. HCC denotes Hierarchical Condition Category.

Web Appendix 4

UPC Score and Lagged Analyses.

	No Lag	1 Month	3 Months	6 Months	12 Months
N	3,200,129	2,994,842	2,732,567	2,439,983	2,009,506
Unadjusted					
Continuity	0.98 (0.98—0.98)	0.98 (0.98—0.98)	0.98 (0.98—0.98)	0.98 (0.98—0.98)	0.97 (0.97—0.98)

	No Lag	1 Month	3 Months	6 Months	12 Months
Adjusted					
Continuity	0.98 (0.98—0.99)	0.98 (0.98—0.99)	0.98 (0.98—0.99)	0.98 (0.98—0.98)	0.98 (0.98—0.98)
Female	1.05 (1.04—1.05)	1.05 (1.04—1.05)	1.05 (1.04—1.05)	1.05 (1.04—1.05)	1.05 (1.05—1.06)
Age	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.01 (1.01—1.01)
Race/ethnicity					
Non-Hispanic white	1.0	1.0	1.0	1.0	1.0
Black	1.04 (1.03—1.04)	1.04 (1.03—1.05)	1.04 (1.04—1.05)	1.04 (1.04—1.05)	1.05 (1.04—1.06)
Hispanic	1.02 (1.02—1.03)	1.01 (1.00—1.02)	1.01 (1.00—1.01)	1.00 (0.99—1.01)	0.99 (0.98—1.00)
Asian	0.94 (0.93—0.95)	0.92 (0.91—0.93)	0.91 (0.90—0.92)	0.90 (0.88—0.91)	0.85 (0.84—0.87)
Other	0.97 (0.96—0.98)	0.96 (0.94—0.97)	0.95 (0.94—0.97)	0.94 (0.93—0.96)	0.92 (0.90—0.94)
Medicaid dual eligible	1.02 (1.02—1.03)	1.02 (1.02—1.02)	1.02 (1.01—1.02)	1.02 (1.01—1.03)	1.03 (1.03—1.04)
Original coverage from disability	1.03 (1.03—1.04)	1.04 (1.03—1.04)	1.05 (1.04—1.05)	1.05 (1.05—1.06)	1.09 (1.08—1.10)
HCC score					
Low	1.0	1.0	1.0	1.0	1.0
Mild	1.03 (1.02—1.03)	1.03 (1.02—1.03)	1.03 (1.03—1.04)	1.04 (1.03—1.04)	1.05 (1.04—1.05)
Moderate	1.05 (1.04—1.05)	1.05 (1.05—1.06)	1.06 (1.05—1.06)	1.06 (1.06—1.07)	1.09 (1.08—1.10)
Severe	1.02 (1.02—1.03)	1.03 (1.02—1.03)	1.03 (1.03—1.04)	1.05 (1.04—1.06)	1.10 (1.10—1.11)
Total visits in prior 12 months	1.01 (1.01—1.01)	1.01 (1.01—1.01)	1.01 (1.01—1.01)	1.01 (1.01—1.01)	1.01 (1.01—1.01)
Total ED episodes in prior 12 months	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.00 (1.00—1.00)	1.01 (1.01—1.01)	1.02 (1.02—1.02)

NOTE: Analyses include continuously enrolled fee-for-service Medicare beneficiaries 66 years of age or older with at least 4 visits in 2011 until death or ED episode, defined as an ED visit and discharge, observation stay through the ED, or admission through the ED. Usual Provider Continuity (UPC) score values are lagged 1, 3, 6, or 12 months and change each month that a beneficiary has an ambulatory evaluation and management visit or held constant. Beneficiaries restricted to those with a minimum number of observation months. UPC score 0.1-unit changes indicate the amount of change in hazard ratio. Total visits are the total number of ambulatory evaluation and management visits per patient and ED episodes are the total number of ED episodes per patient during the 12 months preceding a beneficiary's observation period in the study. Adjusted analyses show risk of emergency visit, observation stay, or emergent hospitalization. All statistically significant results are $P < 0.0001$. HCC denotes Hierarchical Condition Category.

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FIGURE 1.

Continuity of Care over Time by Emergency Department Episode Status.

NOTE: Continuously enrolled Medicare fee-for-service beneficiaries at least 66 years of age had at least 4 ambulatory evaluation and management visits in 2011 and were followed up to 24 months until death or an ED episode, if one occurred. An emergency department (ED) episode is an ED visit and discharge, observation stay through the ED, or admission through the ED. The graphs show mean unadjusted continuity scores at 3-month intervals by whether a beneficiary had an ED episode at some point during his or her observation period in the study. Each month interval is relative to the number of months after a beneficiary's fourth ambulatory evaluation and management visit in 2011.

TABLE 1

Beneficiary Demographic Characteristics.

	Emergency Department Episode	No Emergency Department Episode
N (%)	1,912,866 (59.8)	1,287,292 (40.2)
Female, %	59.6	57.5
Age, mean yrs.	77.9	75.0
Race/ethnicity, %		
Non-Hispanic white	84.7	85.0
Black	7.5	5.7
Hispanic	4.8	4.4
Asian	1.9	3.4
Other	1.1	1.5
Medicaid dual eligible, %	18.8	10.7
Original coverage from disability, %	10.7	6.0
HCC score, %		
Low	20.4	31.8
Mild	22.8	28.6
Moderate	25.2	24.5
Severe	31.7	15.1
Total visits in prior 12 months, median (IQR)	10 (6-15)	7 (5-11)
Total ED episodes in prior 12 months, median (IQR)	0 (0-2)	0 (0-0)

NOTE: An emergency department (ED) episode is an ED visit and discharge, observation stay through the ED, or admission through the ED. Continuously enrolled Medicare fee-for-service beneficiaries at least 66 years of age had at least 4 ambulatory evaluation and management visits in 2011 and were followed up to 24 months until death or an ED episode, if one occurred. Hierarchical Condition Category (HCC) score was calculated from utilization in 2010. Total visits in prior 12 months are the total number of ambulatory evaluation and management visits per patient and ED episodes in prior 12 months are the total number of ED episodes per patient during the 12 months preceding the 4 ambulatory evaluation and management visits in 2011. IQR is interquartile range.

TABLE 2

Beneficiary Demographic Characteristics by Emergency Department Episode.

	ED Visit and Discharge	Observation Stay through ED	Admission through ED
N (%)	1,048,632 (54.8)	249,170 (13.0)	615,064 (32.2)
Continuity, median (IQR)			
COC score	0.231 (0.14-0.40)	0.222 (0.14-0.38)	0.250 (0.16-0.41)
UPC score	0.455 (0.33-0.60)	0.444 (0.33-0.60)	0.478 (0.33-0.63)
Female, %	61.0	59.5	57.1
Age, mean yrs.	77.2	77.8	79.2
Race/ethnicity, %			
Non-Hispanic white	84.2	86.4	84.8
Black	7.8	6.5	7.4
Hispanic	5.0	4.1	4.7
Asian	1.9	1.8	2.1
Other	1.2	1.1	1.0
Medicaid dual eligible, %	18.4	16.9	20.2
Original coverage from disability, %	10.6	10.1	11.0
HCC score, %			
Low	22.7	21.1	16.3
Mild	24.1	23.2	20.3
Moderate	25.4	25.4	24.6
Severe	27.8	30.3	38.8
Total visits, median (IQR)	10 (6-17)	11 (7-18)	10 (6-18)
Hospitalization in previous 30 days, %	2.7	3.0	4.7
Hospitalization on weekend, %	30.4	22.3	30.3

NOTE: Continuity was measured as the average Continuity of Care (COC) score or Usual Provider Continuity (UPC) score during the 12 months prior to an emergency department (ED) episode in 2011, 2012, or 2013 for Medicare fee-for-service beneficiaries at least 66 years of age with at least 4 ambulatory evaluation and management visits in 2011. Total visits represent the total ambulatory evaluation and management visits during the 12 months prior to an ED episode, and hospitalization in the previous 30 days is relative to the ED episode. HCC denotes Hierarchical Condition Category; IQR denotes interquartile range.

TABLE 3

Hazard Ratio of Continuity and Emergency Department Episode Rate.

	Any Emergency Department Episode	
	COC Score	UPC Score
Unadjusted		
Continuity	0.99 (0.99—0.99)	0.98 (0.98—0.98)
Adjusted		
Continuity	0.99 (0.99—0.99)	0.98 (0.98—0.99)
Female	1.05 (1.04—1.05)	1.05 (1.04—1.05)
Age	1.00 (1.00—1.00)	1.00 (1.00—1.00)
Race/ethnicity		
Non-Hispanic white	1.0	1.0
Black	1.04 (1.03—1.04)	1.04 (1.03—1.04)
Hispanic	1.02 (1.02—1.03)	1.02 (1.02—1.03)
Asian	0.94 (0.93—0.95)	0.94 (0.93—0.95)
Other	0.97 (0.96—0.98)	0.97 (0.96—0.98)
Medicaid dual eligible	1.02 (1.02—1.03)	1.02 (1.02—1.03)
Original coverage from disability	1.03 (1.03—1.04)	1.03 (1.03—1.04)
HCC score		
Low	1.0	1.0
Mild	1.03 (1.02—1.03)	1.03 (1.02—1.03)
Moderate	1.05 (1.04—1.05)	1.05 (1.04—1.05)
Severe	1.02 (1.02—1.03)	1.02 (1.02—1.03)
Total visits in prior 12 months	1.01 (1.01—1.01)	1.01 (1.01—1.01)
Total ED visits in prior 12 months	1.00 (1.00—1.00)	1.00 (1.00—1.00)

NOTE: Analyses include continuously enrolled fee-for-service Medicare beneficiaries 66 years of age or older with at least 4 ambulatory evaluation and management visits in 2011 (n = 3,200,129). An emergency department (ED) episode is an ED visit and discharge, observation stay through the ED, or admission through the ED. Continuity of care (COC) score and usual provider continuity (UPC) score change values each month that a beneficiary has a visit or held constant for up to 24 months. COC score or UPC score 0.1-unit changes indicate the amount of change in hazard ratio. Total visits are the total number of ambulatory evaluation and management visits per patient and emergency department (ED) episodes are the total number of ED episodes per patient during the 12 months preceding a beneficiary's observation period in the study. Adjusted analyses include hospital referral region fixed effects and show risk of an ED episode, defined as an ED visit and discharge, observation stay through the ED, or admission through the ED. All statistically significant results are $P < 0.0001$. HCC denotes Hierarchical Condition Category.

TABLE 4
Odds Ratio of Continuity and Emergency Department Episode Risk Among Beneficiaries with an Episode.

	COC Score			UPC Score		
	ED Visit and Discharge	Observation Stay through ED	Admission through ED	ED Visit and Discharge	Observation Stay through ED	Admission through ED
Unadjusted						
Continuity	1.0	0.98 (0.98—0.98)	1.03 (1.03—1.03)	1.0	0.98 (0.97—0.98)	1.03 (1.03—1.03)
Adjusted						
Continuity	1.0	0.99 (0.98—0.99)	1.03 (1.03—1.03)	1.0	0.98 (0.98—0.99)	1.03 (1.03—1.04)
Female	1.0	0.97 (0.96—0.98)	0.90 (0.90—0.91)	1.0	0.97 (0.96—0.98)	0.90 (0.90—0.91)
Age	1.0	1.01 (1.01—1.01)	1.03 (1.03—1.03)	1.0	1.01 (1.01—1.01)	1.03 (1.03—1.03)
Race/ethnicity						
Non-Hispanic white	1.0	1.0	1.0	1.0	1.0	1.0
Black	1.0	0.85 (0.84—0.87)	0.95 (0.93—0.96)	1.0	0.85 (0.84—0.87)	0.95 (0.93—0.96)
Hispanic	1.0	0.83 (0.81—0.85)	0.90 (0.89—0.92)	1.0	0.83 (0.81—0.85)	0.91 (0.89—0.92)
Asian	1.0	1.00 (0.97—1.04)	1.11 (1.08—1.14)	1.0	1.00 (0.97—1.04)	1.11 (1.09—1.14)
Other	1.0	0.94 (0.90—0.98)	0.94 (0.92—0.97)	1.0	0.94 (0.90—0.98)	0.95 (0.92—0.98)
Medicaid dual eligible	1.0	0.94 (0.93—0.95)	1.03 (1.02—1.04)	1.0	0.94 (0.93—0.95)	1.03 (1.02—1.04)
Original coverage from disability	1.0	0.99 (0.97—1.00)	1.09 (1.08—1.10)	1.0	0.99 (0.97—1.00)	1.09 (1.08—1.10)
HCC score						
Low	1.0	1.0	1.0	1.0	1.0	1.0
Mild	1.0	1.01 (1.00—1.03)	1.07 (1.06—1.08)	1.0	1.01 (1.00—1.02)	1.07 (1.06—1.08)
Moderate	1.0	1.04 (1.03—1.06)	1.22 (1.21—1.23)	1.0	1.04 (1.03—1.06)	1.22 (1.21—1.23)
Severe	1.0	1.13 (1.12—1.15)	1.71 (1.70—1.73)	1.0	1.13 (1.12—1.15)	1.71 (1.69—1.73)
Total visits	1.0	1.01 (1.01—1.01)	1.00 (1.00—1.01)	1.0	1.01 (1.00—1.01)	1.01 (1.01—1.01)
Hospitalization in previous 30 days	1.0	1.12 (1.09—1.15)	1.81 (1.78—1.84)	1.0	1.12 (1.10—1.15)	1.80 (1.77—1.83)
Hospitalization on weekend	1.0	0.66 (0.65—0.66)	1.00 (0.99—1.01)	1.0	0.66 (0.65—0.66)	1.00 (0.99—1.01)

NOTE: Continuity was measured in the 12 months prior to an emergency department (ED) episode in 2011, 2012, or 2013 among fee-for-service Medicare beneficiaries at least 66 years of age with at least 4 ambulatory evaluation and management visits in 2011 (n = 1,912,850). Multinomial logistic regression model estimates the risk of observation stay through the ED and admission through the ED relative to an ED visit and discharge. Total visits represent the total ambulatory evaluation and management visits during the 12 months prior to an ED episode, and hospitalization in the previous 30 days is relative to the ED episode. Adjusted analyses include hospital referral region fixed effects. All statistically significant results are P < 0.0001. HCC denotes Hierarchical Condition Category.