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## Do Claims-Based Continuity of Care Measures Reflect the Patient Perspective?

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### Abstract

Continuity of care (CoC) is a cornerstone of the patient-centered medical home (PCMH) and one of the primary means for achieving health care quality. Despite decades of study, however, CoC remains difficult to define and quantify. To incorporate patient experiences into health reform evaluations, it is critical to determine if and how well CoC measures traditionally derived from administrative claims capture patient experiences. In this study, we used claims data and self-reported continuity experiences of 2,620 Medicare beneficiaries who completed the National Health and Health Services Use Questionnaire to compare 16 claims-based CoC indices to a multidimensional patient-reported CoC measure. Our results show that most claims-based CoC measures do *not* reflect older adults' perceptions of continuous patient-provider relationships, indicating that claims-based assessments should be used in tandem with patient reports for defining, quantifying, and evaluating CoC in health care delivery models.

### Keywords

continuity of care; patient reports; older adults

### Introduction

Continuity in the provision of health services has been identified as a key element of good primary care (Institute of Medicine [IOM], 1996; Starfield, Shi, & Macinko, 2005), is highly valued by patients (Rodriguez, Rogers, Marshall, & Safran, 2007; Wasson et al., 1984), and has the potential for improving patient outcomes (Saultz & Lochner, 2005; Wasson et al., 1984). In 2003, the IOM recommended continuity of care (CoC) as a primary aim for improving health care quality (IOM, 2003), especially for older adults with multiple chronic conditions that require comprehensive medical management. Recent health reform initiatives and policies, including the IOM report about achieving the best care at the lowest cost (IOM,

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2012), further highlight the importance of CoC. Moreover, CoC is a cornerstone of the Patient Protection and Affordable Care Act's (ACA) patient-centered medical home (PCMH) model of health care delivery (Center for Policy Studies, 2007).

Despite its centrality for health policy and decades of study, CoC remains difficult to define and quantify (Haggerty et al., 2003; Reid, Haggerty, & McKendry, 2002; Saultz & Lochner, 2005; Starfield, 1980). Thus, rigorous research that carefully defines and operationalizes the critical components of CoC is sorely needed for evaluating health system reforms and their effects on patient outcomes. The purpose of this study is to address that need by comprehensively evaluating multiple claims-based measures of CoC and examine their associations with a recently developed CoC measure based on patients' experiences.

### **New Contribution**

We are unaware of any study to date that has looked at the interrelations between several CoC measures to answer the key question: how do traditional, claims-based measures of longitudinal continuity relate to the duration and quality of the patient-provider relationship from the perspective of older adult patients? Because CoC is a fundamental component of the PCMH and other initiatives promoted by the ACA, the ability to rigorously evaluate it using both claims-based and patient-reported experiences is a crucial step for developing a reliable and valid measure. Only with such a measure can the PCMH, ACA, and other health reforms and initiatives be meaningfully evaluated. If claims-based assessments of CoC adequately capture the experience of patients, then current standards that rely on claims data may be appropriate. If they do not, then the inclusion of patient-reported assessments of CoC will be needed to provide a more complete picture of care provision. This is especially important for understanding CoC from the perspective of older adults with multiple chronic conditions (e.g., hypertension, diabetes, heart failure) and aging-related issues (e.g., falls, incontinence, functional and cognitive decline) who require more coordinated and comprehensive health care, which is a hallmark of CoC (Cabana & Jee, 2004; Weiss & Blustein, 1996; Wolff, Starfield, & Anderson, 2002).

### **Conceptual Framework**

Over the past several decades, hundreds of articles have been published using more than 40 different empirical measures of the CoC concept. Relatively few studies, however, have provided assessments of the reliability or validity of these indices. In 2003, John Saultz provided a comprehensive review of CoC measures, resulting in a long-overdue conceptual definition of CoC. Saultz defined CoC using a hierarchical framework based on providers having enough information about the patient (informational continuity), which facilitates patients having a familiar care setting over time (longitudinal continuity) and culminates in a relationship between the patient and provider characterized by mutual trust and accountability (interpersonal continuity). Several studies have suggested that interpersonal CoC leads to less intensive care (less hospitalization and emergency department use and better preventive care) and lower costs (Weiss & Blustein, 1996; Wolff et al., 2002). The underlying assumption is that CoC allows for interaction and better communication between patients and providers, which fosters a relationship of mutual trust, comfort, and shared information resulting in more accurate provider diagnoses, shared decisions regarding

treatments, and increased patient compliance and adherence to treatment plans. Thus, interpersonal CoC is the essence of quality primary care (Freeman, Olesen, & Hjortdahl, 2003; IOM, 1996; Starfield et al., 2005). It follows, then, that understanding interpersonal continuity is important and requires input from both the patient and the provider.

Most studies, however, have used claims-based measures of longitudinal continuity as a proxy for provider-perceived CoC. This approach assumes that repeated contact with a particular provider is tantamount to having a strong patient-provider relationship. Adequate testing of that assumption has not yet occurred (Reid et al., 2002; Saultz, 2003). Moreover, it is not known whether these proxy measures of the provider perspective are good indicators of either the patient perspective of the duration of the patient-provider relationship (longitudinal continuity) or the quality of the patient-provider interaction (interpersonal continuity).

In 2006, Jee and Cabana expanded Saultz's work by reviewing claims-based CoC indices used in outpatient, primary care settings under the premise that interpersonal continuity is most likely to develop in those settings. They qualitatively assessed the strengths and weaknesses of using CoC indices to measure provider-patient relationships and, in the process, developed a categorization of the various types of claims-based CoC indices. Thirty-two different indices used to measure CoC were identified and classified into five categories: density of visits, dispersion of providers, sequence of provider visits, duration of relationship, and subjective patient estimates. Density indices were the most easily calculated, widely used, and commonly cited (Jee & Cabana, 2006). They require the identification of a particular provider (e.g., most recently seen, most frequently seen) to serve as the index for quantifying patient visit patterns. Dispersion indices expand density indices by accounting for the variety of providers seen by patients, while sequential indices further expand them by accounting for the order in which different providers are seen. In contrast, duration indices measure the total length of the relationship with one provider and are infrequently used in CoC studies.

Subjective CoC measures typically require the patient to identify a particular site or provider of care and, by definition, cannot be calculated using claims. In part because of the additional data collection requirements (surveying patients), few CoC measures reflecting the patient experience were developed until recently (Bentler, Morgan, Virnig, & Wolinsky, 2013; Gulliford, Naithani, & Morgan, 2006; Uijen et al., 2011). One of these, the patient-reported measure developed by Bentler et al. (2013), has recently been shown to be reliable and factorially valid. It taps the patient's experience of longitudinal continuity with their provider as well as the quality of their interaction during visits.

We used Bentler et al.'s (2013) measure of patient experiences in this research because it was developed using data from the 2,620 Medicare beneficiaries who completed the 2004 National Health and Health Services Use Questionnaire (NHHSUQ; Morgan et al., 2008; Wei, Virnig, John, & Morgan, 2006). The NHHSUQ survey data were then linked to Medicare claims for comparison of Bentler's measure to a variety of the claims-based CoC indices to inform the debate about how closely those claims-based indices reflect patient experiences. We used Saultz's (2003) hierarchy and Jee and Cabana's (2006) CoC

categorizations to frame this inquiry. Carrier and outpatient Medicare claims allowed us to create 15 of the CoC indices mentioned in the Saultz and Jee and Cabana reviews, as well as one additional CoC index published afterwards.

In this study, we first evaluated the claims-based indices to confirm the categorizations posited by Jee and Cabana (2006). Second, we examined whether the categories of claims-based measures correlated with our patient-reported measure. Finally, we used Andersen's behavioral model of health services use (Andersen, 1968, 1995), which categorizes the use of health services as a function of the predisposing, enabling, and need characteristics of the individual to adjust for case-mix. Two hypotheses guided our study. We expected that the patient experience of longitudinal CoC would relate most strongly to the claims-based density measures because both types of indices are visit-based measures of the duration of care with a specific provider; one derived from patient recall and the other from provider billing. And, we expected little or no relationship between the patient-reported experience of interpersonal CoC and the claims-based, provider proxy measures because it is unlikely that provider billing adequately captures the quality of the patient-provider interaction experienced by the patient at each visit.

## Method

### Sample and Data Sources

The 2004 NHHSUQ was designed to identify factors affecting Medicare managed care (MMC) plan enrollment. It was mailed to a disproportionately stratified random sample of 6,060 community-residing Medicare beneficiaries 65 years old or older in the fall of 2004 to obtain equal numbers of participants with regard to race/ethnicity (White, Black, Hispanic), Medicare plan type (Medicare fee-for-service [FFS] or MMC), sex, and population density (Morgan et al., 2008). The response rate after adjusting for ineligible survey recipients (e.g., noncommunity residing, moved out of geographic area, or deceased) was 53% (2,997/5,697). Construction of the claims-based CoC measures focused on the 2,620 Medicare beneficiaries who had complete data for the 13 continuity-related NHHSUQ items and who were likely to have complete Medicare claims for the period 2002 to 2004. There was an average of 3 missing items per person with incomplete data. Among the 2,620 who completed all items, there were slightly more males (51% vs. 45%), Whites (38% vs. 30%), and people who had at least a high school education (65% vs. 44%) and slightly fewer Blacks (30% vs. 38%) compared to the 377 who did not complete all items. Because by design half of the NHHSUQ respondents were in MMC plans, they were excluded due to the different billing reporting requirements for Part B (non-institutional) claims (Asper, 2007). Thus, the analytic sample was reduced to the 1,219 people with complete survey responses who had both Part A and Part B coverage and were not enrolled in managed care. Medicare claims were restricted to the 13,896 unique Carrier and Outpatient claims for an Evaluation and Management (E&M) visit in the year prior to the survey. In sensitivity analyses all Outpatient and Carrier claims (26,046 claims) were used, as were 2 years of claims (48,334 claims, of which 25,899 were E&M claims). These sensitivity analyses yielded comparable results (available on request).

### Claims-Based Continuity of Care Measures

Using the Medicare claims, we created nine density indices: six of the eight identified by Jee and Cabana (Current Provider of Care, Current Provider of Care—discounted, Usual Provider of Care, Clinician Index, Site Index, and Herfindahl Index) plus three measures (Continuity Index, Wolinsky Continuity, and Known Provider) from additional literature reviews (Breslau & Reeb, 1975; Eriksson & Mattsson, 1983; Mainous & Gill, 1998; Smedby, Eklund, Anders Eriksson, & Smedby, 1986; Wolinsky et al., 2007). Six dispersion indices were created: five were identified by Jee and Cabana (2006; Bice-Boxerman CoC, Ejlertsson’s K Index, the Modified Continuity Index, Personal Provider Continuity, and the Modified, Modified Continuity Index) plus one (Inverse Number of Providers) from additional literature reviews (Bice & Boxerman, 1977; Ejlertsson & Berg, 1984; Magill & Senf, 1987; Parchman, Pugh, Hitchcock Noel, & Larme, 2002; Sturmberg, 2002; Sturmberg & Schattner, 2001). We also created one sequential continuity index (Steinwachs, 1979) identified by Jee and Cabana. We could not create any duration indices using these claims data. All indices were calculated so that higher values represented high levels of continuity. Table 1 provides the categories, definitions, examples, and references for the claims-based CoC measures created.

### Patient-Reported Continuity of Care

Our patient-reported CoC measure is a 13-item scale derived from patient responses to a subset of NHHSUQ questions (Bentler et al., 2013). It has four subscales: two tap longitudinal continuity (Care Site and Provider Duration) and two tap interpersonal continuity (Instrumental and Affective). The Care Site subscale had two items asking the respondent if they had a site they visited most often for medical care and, if so, to identify the site (doctor’s office, Veterans’ Affairs Medical Center, emergency room, or other). The Provider Duration subscale had three items: long-term duration of care at the named site, long-term duration of care with a regular doctor, and short-term duration of care (within the past year) with the regular doctor. Cronbach’s alpha coefficients for the longitudinal continuity subscales of Care Site and Provider Duration were 0.88 and 0.75, respectively.

The Instrumental subscale had four items that tapped the technical care aspects of the patient–provider relationship. Three of the items (thoroughness of examinations, accuracy of diagnoses, and explanations of medical procedures and tests) were rated on a scale from *excellent* (5) to *poor* (1) while the fourth item (knowledge about your health and health care) was rated on a scale from *very knowledgeable* (4) to *not knowledgeable* (1). The Affective subscale also had four items tapping the “people skills” aspect of the patient–provider interaction. Two items asked participants to rate “your primary doctor’s interest in you” and “your primary doctor’s interest in your medical problems” on a scale from *excellent* (5) to *poor* (1), one asked respondents to rate their satisfaction with their health care on a scale from *very satisfied* (4) to *very dissatisfied* (1), and the fourth asked respondents to rate “How comfortable are you with your primary doctor or with the providers at your usual place of care” on a scale from *very comfortable* (5) to *very uncomfortable* (1). The Instrumental and Affective relationship continuity scales had Cronbach’s alpha coefficients of 0.88 and 0.87, respectively.

Table 2 provides the item counts, mean scores, and intercorrelation between the four subscales and the overall patient-reported CoC measure. While all of the correlation coefficients among the patient-reported scales were statistically significant, the highest were among the overall CoC scale and both the Instrumental and Affective subscales. The least correlated subscales were between Care Site and each of the Instrumental and Affective subscales while the other scale relationships were of moderate strength. While the Instrumental and Affective subscales are highly correlated, both theoretically (Ben-Sira, 1980) and in previous empirical work (Bentler et al., 2013), it has been demonstrated that they capture different aspects of interpersonal continuity. Thus, these results indicate that while all subscales tap the overall CoC construct, they each capture a different domain of the CoC concept.

### Covariates

To obtain the independent effect of the claims-based CoC measures on the patient-reported CoC measure, we adjusted for potential confounders available in the NHHSUQ. Measures of predisposing characteristics included patient-reported age (categorized as 70, 71 to 76, and >76), sex, race/ethnicity (White, Black, and Hispanic), marital status (married or not), and education (high school education or greater vs. less). We used an indicator of having supplemental insurance (in addition to Medicare) and population density (living in a metropolitan area) as measures of enabling characteristics. Finally, indicators of the need for health services included self-reported smoking status, the SF-8 measure of health-related quality of life (Ware, Kosinski, Dewey, & Gandek, 2001), and the number of health conditions (e.g., hypertension, diabetes, and stroke).

### Statistical Analyses

SAS Version 9.2 and SPSS Version 20 were used for all analyses. We used means, standard deviations, and Pearson correlation coefficients to describe the CoC measures. Exploratory factor analysis (EFA) was used to characterize the claims-based CoC indices. Factors were initially extracted using principal components methods with an oblique factor rotation (oblimin). In sensitivity analyses, we used a promax oblique rotation, and the results were comparable. To determine the appropriate number of factors to retain, we used Kaiser–Guttman eigenvalue criteria for common factors (Guttman, 1954; Kaiser, 1960), and we required that at least 75% of the total variation in the items be explained by the extracted factors. Final criteria for our factors involved having at least two indices with primary loadings on each factor, with indices loading on each common factor sharing conceptual meaning (Child, 1990; Tabachnick & Fidell, 2001).

We used linear regression techniques to evaluate the association between the patient-reported (full scale and each subscale) and claims-based CoC measures. Because all items in the patient-reported CoC indices do not have the same response set, we first normalized each item by transforming it into a *z*-score. Then, we summed the *z*-scores for each subscale and for the overall scale. This gave each item equal weight in the analyses but advantaged subscales with more items. In sensitivity analyses, we normalized each subscale by taking *z*-scores of its sum (i.e., giving each subscale equal weight) and found comparable results. Factor scores derived from the EFA of the claims-based CoC indices were used as the focal

independent variables because each factor score represented a conceptually meaningful claims-based construct and to avoid the multicollinearity that would have occurred if the individual claims-based CoC indices were used. Each dependent variable (patient-reported CoC, Care Site, Provider Duration, Instrumental, and Affective) was modeled with only the EFA factor scores first and with the addition of the covariates second.

## Results

### Sample Characteristics

The average age was 74 (range = 65-99,  $SD = 7$ ). About half were women, 42% were White, 30% were Black, 27% were Hispanic, and 57% were married. The majority (60%) came from urban areas. Less than half (44%) had at least a high school education, and most (88%) reported having a supplemental health insurance plan. The majority reported good to excellent health (60%) and were nonsmokers (91.0%). Over three fourths (77%) had at least three health conditions with hypertension (63%), arthritis (59%), and hyperlipidemia (49%) being the most frequently reported.

### CoC Measure Characteristics

Table 2 provides the means and standard deviations of each CoC index as well as the correlation coefficients between indices. The claims-based index scores ranged from 27% (Bice-Boxerman CoC) to 89% (Site Index). Aside from the Site Index (which atypically uses site instead of provider type), the highest claims-based continuity score was 62% for the Known Provider. All 16 of the claims-based CoC measures correlated at the 0.30 level with at least one other claims-based measure, suggesting reasonable factorability (Tabachnick & Fidell, 2001).

### Exploratory Factor Analysis

Table 3 provides the EFA results for the claims-based CoC measures. The communalities for each measure were well above 0.30, indicating shared common variance. The initial eigenvalues showed that the first factor explained almost 54% of the variance, the second factor almost 21 %, and the third factor almost 7% for a three-factor solution explaining 82% of the total item variance. All measures had primary factor loadings 0.69, although many also had cross-loadings >0.35. Thus, the three-factor solution was retained.

The categorizations proposed by Jee and Cabana fit the extracted factors with some exceptions. The Modified, Modified Continuity Index (a dispersion measure) loaded primarily with the density factor (although it had a high secondary loading with the dispersion factor), the Known Provider measure (a density measure) loaded primarily with the dispersion factor, the Sequential Continuity measure loaded with the dispersion factor, and the Site Index ( a density measure) loaded primarily on the third factor but cross-loaded with both the density and dispersion factors. The Wolinsky Continuity measure (not included in the Jee and Cabana review) loaded primarily on the third factor. We labeled Factors 1, 2, and 3 as Concentration, Dispersion, and Longitudinality, respectively, based on the measures driving each. The correlations between the Dispersion factor and the Concentration and

Longitudinality factors were 0.35 and 0.32, respectively. The Concentration and Longitudinality factors were uncorrelated (0.02).

### Association Between Patient-Reported CoC and Claims-Based CoC

Table 4 shows the results from the linear regression models using the claims-based factor scores to predict each of the patient-reported CoC scales. Panel A shows the results without adjusting for the covariates. The claims-based Concentration factor was only associated with one patient-reported subscale, Care Site ( $p = .02$ ). The more sophisticated claims-based Dispersion factor was not associated with either the Care Site or the Provider Duration subscales but had some association with both the interpersonal ( $p = .02$ ) and the full patient-reported CoC scales ( $p = .04$ ). However, the claims-based Longitudinality factor was strongly associated ( $p < .001$ ) with the patient-reported CoC scale and all of its subscales at the  $p < .05$  level. As shown in Panel B, adjusting for patient characteristics did not appreciably alter these findings.

### Discussion

Accurately determining a patient's care continuity is important for adequately compensating providers (demonstrating CoC is required in most PCMH models) and for evaluating how CoC affects patient health outcomes (as prioritized by PCORI). The most commonly used CoC measures have been claims-based proxies from the provider's perspective (Jee & Cabana, 2006; Saultz, 2003; Stanek & Takach, 2010). Indeed, to date little has been known about whether these measures adequately assess the quality of the patient-provider interaction (the essence of good continuity of care) because they do not incorporate patient perceptions. Our results showed that most claims-based CoC measures were not reflective of patient perceptions of the quality of their provider-patient interaction.

The most widely used claims-based measures are those that identify a particular provider with CoC based on the concentration of visits with that provider. Health care organizations trying to obtain PCMH recognition from accreditors like the National Committee on Quality Assurance or the Joint Commission are more likely to use concentration measures because they are the easiest to calculate (O'Malley, Peikes, & Ginsburg, 2008; Stanek & Takach, 2010). Even though we expected the concentration factor to be somewhat associated with the patient experience of longitudinal CoC (which includes identification of consistent visits to an identified provider/site), our findings showed that the concentration factor related most strongly with patient perceptions of having a regular *site* of care and not at all with the consistency or duration of visits. As expected, the concentration factor also had no association with the relationship aspects of continuity. The more sophisticated claims-based dispersion CoC factor was more strongly related to patient perceptions than the concentration factor, especially regarding the interpersonal aspects of the patient experience of CoC. While not expected, this result may not be surprising considering that people with chronic conditions (who are prevalent in this sample of older adults) may establish care with several different providers to manage their illnesses and, if effective, their patient-provider relationships thrive (Love, Mainous, Talbert, & Hager, 2004; Nutting, Goodwin, Flocke, Zyzanski, & Stange, 2003).



We were somewhat surprised that some claims-based measures were related to the patient experience. The claims-based longitudinality factor was most strongly associated with all components of patient-reported CoC. In post hoc regression analyses, we estimated the relationship between the two individual claims-based indices from the longitudinality factor (the Site Index and Wolinsky Continuity measures) and each of the patient-reported measures. Not unexpectedly, the claims-based Site Index ( $b = 0.99, p < .001$ ) was most associated with the patient-reported Care Site subscale. However, the Wolinsky Continuity measure had stronger independent associations with each of the other patient-reported subscales (Duration  $b = 1.15, p < .001$ ; Instrumental  $b = 0.63, p = .001$ ; Affective  $b = 0.47, p = .01$ ), while both the claims-based Site Index ( $b = 2.19, p = .003$ ) and Wolinsky measure ( $b = 2.39, p < .001$ ) were significantly associated with the full patient-reported CoC scale. The association with the interpersonal subscales was perhaps the most surprising given the prevailing thought that claims-based measures may not adequately capture the patient-provider relationship (Saultz, 2003; Stanek & Takach, 2010). The Wolinsky measure, by definition, uses at least 2 years of E&M visit claims to identify continuity, and it may be that this operationalization best conceptualizes what patients consider when visiting their regular provider.

One limitation of this work is that we were not able to calculate every extant claims-based CoC measure. We were, however, able to recreate the two most commonly used measures (i.e., Usual Provider of Care and the Continuity of Care Index). Another limitation is that we were only able to use the survey data and claims from respondents in FFS Medicare due to differential reporting requirements in managed care Medicare plans. In our previous work (Bentler et al., 2013), we found that the patient-reported CoC model was factorially invariant between those in FFS versus MMC plans, suggesting that, at least for patient experiences of continuity, there is consistency between plan types. Regardless, because choice of providers may be limited within some (especially closed panel) MMC plans, these findings may not generalize to such managed care arrangements. Finally, the CoC experienced by these older Medicare beneficiaries may not generalize to younger people.

In general, there was a disjuncture between claims-based and patient perceptions of continuity. Given the increased advocacy for the use of patient-reported indicators of quality and outcomes by organizations such as National Committee for Quality Assurance (2011) and Patient-Centered Outcomes Research Institute (2012), but the traditional reliance on administrative claims (O'Malley et al., 2008; Stanek & Takach, 2010), our results have important implications. Most important, using a mixed method (i.e., both patient reports and administrative claims) when assessing care continuity may be the most valid approach for evaluating how CoC relates to patient outcomes. While the use of administrative claims may be adequate if the objective is only to evaluate visit continuity, it is clear that only patient reports provide adequate assessments of interpersonal continuity.

That said, some have suggested that in certain settings patient-reports may overestimate visit continuity (Rodriguez, Marshall, Rogers, & Safran, 2008) or, due to resource constraints, simply may not be obtainable (O'Malley et al., 2008; Stanek & Takach, 2010). Our findings also have implications for assessing CoC in situations where using patient reports may not be feasible. In these instances, claims-based proxies such as the Wolinsky Continuity

measure, which are derived from E&M visits to particular providers over a longer time period, could be used as valid approximations of the patient experience. In future studies, we will further validate these CoC measures by using them to predict health outcomes and service use in older adults.

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**Table 1.** Summary of Claims-Based Continuity of Care Measures Obtained for the NHHSUQ Survey Respondents.

CoC measure	Category <sup>a</sup>	Definition	Formula <sup>b</sup>	Example of CoC calculation <sup>c</sup>
Current Provider of Care: CPC (Smedby, 1986)	Density	In a 1-year period, the total number of visits to the most recently seen provider divided by the total number of visits.	$CPC = \frac{v_c}{W}$	CPC = 0.25
Current Provider of Care—discounted: CPCd (Smedby, 1986)	Density	The fraction of visits in the previous year to the current provider after weighting visits based on proximity to index visit. Value of visits to the current provider decreases as time goes on. $\tau$ = the half-life. For example, if $\tau = 0.25$ year, visit values are 0.5, 0.25, 0.125, ...	$CPCd = \frac{v_c(\tau)}{w(\tau)}$	CPCd = 0.38
Usual Provider of Care: UPC (Breslau & Reeb, 1975)	Density	The fraction of visits in the previous year to the usual (most frequently visited) provider.	$UPC = \frac{v_u}{W}$	UPC = 0.50
High Clinician Continuity: HCC (Mainous & Gill, 1998)	Density	The fraction of visits to the usual provider was at least 50%.	HCC = 1 where UPC = 0.5 0 otherwise	HCC = 1
High Site Continuity: HSC (Mainous & Gill, 1998)	Density	The fraction of visits to the most frequently used type of care site was at least 50%.	$HSC = 1$ where $\frac{v_s}{W} \geq 0.5$ 0 otherwise	HSC = 0 If Provider A and C are from the same practice, $\frac{v_s}{W} = 0.38$
Continuity Index: CI (Mainous & Gill, 1998)	Density	A score of continuity based on HCC and HSC.	CI = 0: HCC & HSC = 0 CI = 0.5: HCC = 0 & HSC = 1 CI = 1: HCC = 1	CI = 1
Herfindahl Index: HI (Eriksson & Mattsson, 1983; Smedby et al., 1986)	Density	The sum of the squared fractions of visits by all providers.	$HI = \sum_{i=1}^n \left(\frac{v_i}{W}\right)^2$	HI = 0.34
Wolinsky Continuity: WoIC (Wolinsky et al., 2007)	Density	If there was at least 1 visit to the same provider every 8 months over the previous 2 year period.	WoIC = 1 if at least 1 visit to same provider every 8 months (2 year period) 0 otherwise	Need a 2-year period to calculate
Known Provider: KP (Smedby et al., 1986)	Density/sequential	If the current (most recently seen) provider was seen at least one more time in the previous year.	KP = 1 where $v_c > 1$ 0 otherwise	KP = 1
Sequential Continuity: SECON (Steinwachs, 1979)	Sequential	The fraction of sequential visit pairs at which the same provider is seen.	$SECON = \frac{\sum w_i = 2^q i}{w - 1}$ , where $w - 1$ is the number of sequential pairs, $q_i = 1$ if $v_i$ and $v_{i+1}$ are to the same provider and 0 otherwise.	SECON = 1/7 = 0.14
Inverse Number of Providers: INOP (Eriksson & Mattsson, 1983)	Dispersion	The inverse of the total number of different providers seen during the previous year.	INOP = 1/n	INOP = 0.125

CoC measure	Category <sup>a</sup>	Definition	Formula <sup>b</sup>	Example of CoC calculation <sup>c</sup>
Bice-Boxerman CoC: BBC (Bice & Boxerman, 1977)	Dispersion	Applies the Herfindahl Index to one patient's visit pattern. The score increases with the number of visits made.	$BBC = \frac{HI - (1/w)}{1 - (1/w)}$	BBC = 0.25
Ejlertsson's Index K: EK (Ejlertsson & Berg, 1984)	Dispersion	Similar to Bice-Boxerman but modifies the number of providers to the number of providers divided by the number of visits.	$EK = \frac{w-n}{w-1}$	EK = 0.57
Modified Continuity Index: MCI (Sturmberg, 2002; Sturmberg & Schattner, 2001)	Dispersion	Equals 1 minus the number of providers divided by the number of visits. This index is adjusted for utilization by ascribing a higher value to those who have more frequent visits to the same provider.	$MCI = 1 - \frac{n}{w + 0.1}$	MCI = 0.51
Personal Provider Continuity: PPC (Sturmberg, 2002; Sturmberg & Schattner, 2001)	Dispersion	A dichotomous version of the MCI	PPC = 1 where MCI > 0.66 0 otherwise	PPC = 0
Modified, Modified Continuity Index: MMCI (Magill & Senf, 1987; Parchman et al., 2002)	Dispersion	This is the Modified Continuity Index divided by 1 minus the inverse number of visits.	$MMCI = \frac{1 - \frac{n}{w + 0.1}}{1 - \frac{1}{w + 0.1}}$	MMCI = 0.58

<sup>a</sup>From the Jee and Cabana (2006) categorization of continuity of care measures. Patient-reported measures come from patient surveys. Density measures use the identification of a particular index provider to serve as the reference for quantifying a patient's visit pattern. Dispersion continuity indices measure the degree to which care is sought by different providers. The sequential index is similar to dispersion with the addition of taking into account the order in which providers are seen.

<sup>b</sup>Observation time period is 1 year, unless indicated otherwise. Formulas include the following variables:  $i$  = the  $i$ th provider;  $c$  = most recently seen provider;  $n$  = most frequently seen provider;  $s$  = most frequently seen site of care;  $v$  = number of visits with a particular provider;  $n$  = total number of visited providers;  $w$  = total number of visits.

<sup>c</sup>Consider the following visit pattern in a 1-year period where each letter represents a different provider: ABABBCBD. In this example,  $w = 8$  visits;  $n = 4$  providers seen;  $i = 1$  to 8;  $v_1 = 2$ ;  $v_2 = 4$ ;  $v_3 = 1$ ;  $v_4 = 1$ .

**Table 2.** Descriptive Statistics for the Continuity of Care Measures Obtained From the 1,219 NHHSUQ Survey Respondents in Medicare FFS.

Measures	M (SD)	Pearson correlation coefficients																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>Patient-Reported (Items)</i>																					
Care site (2)	1 4.8 (0.75)	—																			
Duration (3)	2 9.6 (4.93)	<b>.22</b>	—																		
Instrumental (4)	3 14.8 (2.99)	<b>.11</b>	<b>.26</b>	—																	
Affective (4)	4 15.8 (2.79)	<b>.09</b>	<b>.27</b>	<b>.84</b>	—																
Patient-Reported Continuity (13)	5 45.0 (8.46)	<b>.38</b>	<b>.59</b>	<b>.87</b>	<b>.87</b>	—															
<i>Claims-Based</i>																					
Current Provider of Care	6 0.41 (0.32)	<b>.06</b>	<b>.05</b>	<b>.02</b>	<b>.04</b>	<b>.05</b>	—														
Current Provider of Care (Discounted)	7 0.46 (0.32)	<b>.08</b>	<b>.04</b>	<b>.02</b>	<b>.04</b>	<b>.06</b>	<b>.97</b>	—													
Usual Provider of Care	8 0.50 (0.29)	<b>.10</b>	<b>.08</b>	<b>.05</b>	<b>.06</b>	<b>.09</b>	<b>.87</b>	<b>.86</b>	—												
High Clinician Continuity	9 0.52 (0.50)	<b>.06</b>	<b>.04</b>	<b>.03</b>	<b>.05</b>	<b>.06</b>	<b>.69</b>	<b>.68</b>	<b>.80</b>	—											
High Site Continuity	10 0.89 (0.31)	<b>.19</b>	<b>.13</b>	<b>.06</b>	<b>.06</b>	<b>.13</b>	<b>.43</b>	<b>.48</b>	<b>.58</b>	<b>.36</b>	—										
Continuity Index	11 1.41 (0.67)	<b>.13</b>	<b>.09</b>	<b>.05</b>	<b>.06</b>	<b>.10</b>	<b>.70</b>	<b>.72</b>	<b>.86</b>	<b>.90</b>	<b>.72</b>	—									
Herfindahl Index	12 0.41 (0.29)	<b>.07</b>	<b>.06</b>	<b>.02</b>	<b>.03</b>	<b>.06</b>	<b>.90</b>	<b>.88</b>	<b>.97</b>	<b>.76</b>	<b>.48</b>	<b>.78</b>	—								
Wolinsky Continuity	13 0.45 (0.50)	<b>.09</b>	<b>.25</b>	<b>.11</b>	<b>.09</b>	<b>.18</b>	<b>-.04</b>	<b>-.05</b>	<b>.05</b>	<b>.01</b>	<b>.29</b>	<b>.14</b>	<b>-.05</b>	—							
Known Provider	14 0.62 (0.49)	<b>.11</b>	<b>.09</b>	<b>.06</b>	<b>.06</b>	<b>.11</b>	<b>.33</b>	<b>.32</b>	<b>.21</b>	<b>.38</b>	<b>.41</b>	<b>.30</b>	<b>.12</b>	<b>.38</b>	—						
Sequential Continuity	15 0.28 (0.29)	<b>.07</b>	<b>.00</b>	<b>.03</b>	<b>.03</b>	<b>.04</b>	<b>.45</b>	<b>.45</b>	<b>.58</b>	<b>.48</b>	<b>.33</b>	<b>.50</b>	<b>.54</b>	<b>.13</b>	<b>.43</b>	—					
Inverse Number of Providers	16 0.33 (0.29)	<b>.05</b>	<b>.04</b>	<b>-.02</b>	<b>-.01</b>	<b>.01</b>	<b>.86</b>	<b>.85</b>	<b>.87</b>	<b>.64</b>	<b>.38</b>	<b>.65</b>	<b>.95</b>	<b>-.15</b>	<b>.02</b>	<b>.42</b>	—				
Bice-Boxerman CoC	17 0.27 (0.26)	<b>.08</b>	<b>.04</b>	<b>.07</b>	<b>.06</b>	<b>.08</b>	<b>.55</b>	<b>.52</b>	<b>.66</b>	<b>.56</b>	<b>.34</b>	<b>.57</b>	<b>.61</b>	<b>.21</b>	<b>.49</b>	<b>.90</b>	<b>.47</b>	—			
Ejertsson's Index K	18 0.52 (0.32)	<b>.13</b>	<b>.09</b>	<b>.10</b>	<b>.09</b>	<b>.14</b>	<b>.25</b>	<b>.23</b>	<b>.39</b>	<b>.29</b>	<b>.52</b>	<b>.45</b>	<b>.28</b>	<b>.47</b>	<b>.70</b>	<b>.74</b>	<b>.11</b>	<b>.80</b>	—		
Modified Continuity Index	19 0.46 (0.27)	<b>.14</b>	<b>.10</b>	<b>.12</b>	<b>.12</b>	<b>.16</b>	<b>.18</b>	<b>.16</b>	<b>.34</b>	<b>.23</b>	<b>.55</b>	<b>.42</b>	<b>.20</b>	<b>.52</b>	<b>.68</b>	<b>.61</b>	<b>.01</b>	<b>.66</b>	<b>.96</b>	—	
Personal Provider Continuity	20 0.29 (0.45)	<b>.05</b>	<b>.06</b>	<b>.11</b>	<b>.13</b>	<b>.13</b>	<b>.19</b>	<b>.15</b>	<b>.24</b>	<b>.18</b>	<b>.20</b>	<b>.23</b>	<b>.19</b>	<b>.33</b>	<b>.39</b>	<b>.40</b>	<b>.05</b>	<b>.47</b>	<b>.61</b>	<b>.67</b>	—
Modified, Modified Continuity Index	21 0.59 (0.30)	<b>.12</b>	<b>.12</b>	<b>.07</b>	<b>.08</b>	<b>.13</b>	<b>.66</b>	<b>.62</b>	<b>.79</b>	<b>.52</b>	<b>.63</b>	<b>.67</b>	<b>.73</b>	<b>.29</b>	<b>.45</b>	<b>.55</b>	<b>.62</b>	<b>.61</b>	<b>.69</b>	<b>.70</b>	<b>.49</b>

Note. Correlations in boldface are statistically significant at the  $p < .05$  level.

**Table 3.**

Factor Loadings and Communalities Based on a Principal Components Analysis With Oblimin Rotation for 16 Claims-Based CoC Measures ( $n = 1,219$  FFS Medicare Beneficiaries).

CoC measure	Loadings			Communality
	Concentration	Dispersion	Longitudinality	
Herfindahl Index	<b>0.977</b>	0.340	-0.057	0.962
Usual Provider of Care	<b>0.974</b>	0.436	0.087	0.960
Current Provider of Care	<b>0.926</b>	0.321	-0.010	0.859
Discounted Current Provider of Care	<b>0.925</b>	0.294	0.011	0.857
Number of Providers (Inverse)	<b>0.920</b>	0.169	-0.157	0.891
Continuity Index	<b>0.865</b>	0.435	0.314	0.838
High Clinician Continuity	<b>0.824</b>	0.341	-0.007	0.684
Modified, Modified Continuity Index	<b>0.725</b>	0.672	0.417	0.797
Ejlertsson's Index: K	0.306	<b>0.962</b>	0.470	0.956
Modified Continuity Index	0.230	<b>0.918</b>	0.596	0.951
Bice-Boxerman Continuity of Care	0.604	<b>0.862</b>	0.003	0.912
Sequential Continuity	0.535	<b>0.822</b>	-0.068	0.848
Personal Provider Continuity	0.160	<b>0.715</b>	0.260	0.522
Known Provider	0.208	<b>0.693</b>	0.499	0.567
Wolinsky Continuity	-0.049	0.422	<b>0.731</b>	0.596
High Site Continuity	0.557	0.400	<b>0.700</b>	0.783
Factor statistics				
Eigenvalue	8.58	3.31	1.09	
% of Total variance explained	53.6	20.7	6.8	
Correlations				
Concentration	—	0.35	0.02	
Dispersion	0.35	—	0.32	
Longitudinality	0.02	0.32	—	

Note. Total variance explained by the three factors = 81.1%.



**Table 4.**

Linear Regression of Each Patient-Reported Continuity Scale by the Claims-Based Factor Scores.

Panel A	Care Site Subscale, <i>b</i> ( <i>SD</i> )	Duration Subscale, <i>b</i> ( <i>SD</i> )	Instrumental Subscale, <i>b</i> ( <i>SD</i> )	Affective Subscale, <i>b</i> ( <i>SD</i> )	Full Patient-Reported CoC Scale, <i>b</i> ( <i>SD</i> )
Concentration	0.13 (0.05)*	0.14 (0.07)	-0.03 (0.10)	0.03 (0.10)	0.26 (0.23)
Dispersion	0.05 (0.06)	-0.04 (0.08)	0.26 (0.10)*	0.23 (0.10)*	0.50 (0.24)*
Longitudinality	0.25 (0.05) <sup>‡</sup>	0.54 (0.07) <sup>‡</sup>	0.25 (0.10)*	0.20 (0.09)*	1.24 (0.23) <sup>‡</sup>
Panel B <sup>a</sup>	Care Site Subscale, <i>b</i> ( <i>SD</i> )	Duration Subscale, <i>b</i> ( <i>SD</i> )	Instrumental Subscale, <i>b</i> ( <i>SD</i> )	Affective Subscale, <i>b</i> ( <i>SD</i> )	Full PR-CoC Scale, <i>b</i> ( <i>SD</i> )
Concentration	0.12 (0.05)*	0.13 (0.08)	-0.15 (0.10)	-0.07 (0.09)	0.03 (0.23)
Dispersion	0.06 (0.06)	-0.02 (0.08)	0.43 (0.10) <sup>‡</sup>	0.37 (0.10) <sup>‡</sup>	0.83 (0.24) <sup>‡</sup>
Longitudinality	0.21 (0.06) <sup>‡</sup>	0.43 (0.08) <sup>‡</sup>	0.30 (0.10) <sup>‡</sup>	0.26 (0.10) <sup>‡</sup>	1.21 (0.23) <sup>‡</sup>

\*  $p < .05$ .†  $p < .01$ .‡  $p < .001$ .

<sup>a</sup>These models were adjusted for age, sex, race/ethnicity, marital status, education, supplemental insurance status, residential population density, self-rated general health status, number of comorbidities, and smoking status.