HHS Public Access

Author manuscript

Med Care. Author manuscript; available in PMC 2017 May 01.

Published in final edited form as:

Med Care. 2016 May ; 54(5): e30–e34. doi:10.1097/MLR.0000000000000018.

Measuring Care Continuity: A Comparison of Claims-Based Methods

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Abstract

Background—Assessing care continuity is important in evaluating the impact of health care reform and changes to health care delivery. Multiple measures of care continuity have been developed for use with claims data.

Objective—This study examined whether alternative continuity measures provide distinct assessments of coordination within pre-defined episodes of care.

Research Design and Subjects—Retrospective cohort study using 2008–9 claims files for a national 5% sample of beneficiaries with congestive heart failure, chronic obstructive pulmonary disease, and diabetes mellitus.

Measures—Correlation among four measures of care continuity—the Bice-Boxerman Continuity of Care Index, Herfindahl Index, usual provider of care, and Sequential Continuity of Care Index—derived at the provider- and practice-levels.

Results—Across the three conditions, results on four claims-based care coordination measures were highly correlated at the provider level (Pearson correlation coefficient $r = 0.87$ to 0.98) and practice level ($r = 0.75$ to 0.98). Correlation of the results was also high for the same measures between the provider and practice levels ($r = 0.65$ to 0.92).

Conclusion—Claims-based care continuity measures are all highly correlated with one another within episodes of care.

Keywords

Coordinated care; continuity of care; claims analysis

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All authors report no conflicts of interest.

INTRODUCTION

Care coordination has been identified as a priority area by the National Priorities Partnership and the Institute of Medicine.[1,2] New models of patient care coupled with new provider payment mechanisms - including bundled payment, Accountable Care Organizations, and patient-centered medical homes - are expected to achieve reductions in costs and increases in quality through improved care coordination.[3–7] In this setting, measuring care coordination is viewed as critical to determine which populations or clinical areas are the most promising targets for interventions and to monitor the effectiveness of those interventions over time.[8]

Many distinct aspects of care coordination can be measured, and a variety of measurement approaches exist.[9] Previous studies have found that increased continuity is associated with lower costs, lower rates of hospitalization, and higher satisfaction.[10] One prominent approach involves the use of claims data to measure care "continuity" or "fragmentation."[11] While these claims-based measures have important limitations as measures of care coordination,[12] claims data have some advantages as well. Claims databases include large numbers of beneficiaries (all beneficiaries covered by an insurance plan, or in the case of multi-payer claims databases, multiple payers) and provide a comprehensive record of the billed services provided to those beneficiaries. The data are also relatively inexpensive to collect and analyze relative to methods that involve primary data collection or interviews. As new care models evolve in response to payment reform, claims-based continuity measures are likely to be important to assessing coordination of care.

The objective of this article is to compare results on four previously-developed claims-based continuity measures that assess patterns of visits to providers in order to assess whether they provide distinct information about the continuity of care within clinical episodes. Three of the four measures—the Bice-Boxerman Continuity of Care Index, the Herfindahl Index, and the Usual Provider of Care—reflect the extent to which a patient's visits are concentrated among a single provider or practice group. The fourth, the Sequential Continuity of Care Index, considers the order of visits, representing the number of handoffs that exist between providers.

While the measures use distinct specifications, the extent to which they may be correlated is unclear. In addition, we sought to assess whether continuity mneasures constructed using visits to individual providers and to practices would e correlated with one another.

METHODS

Data Sources and Sample Selection

We measured care continuity during episodes of care for a sample of Medicare beneficiaries with congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and/or diabetes mellitus (DM). Beneficiaries and their health care utilization were identified using 5% Medicare claims files from 2008 and 2009. Patients were eligible for inclusion if they were over 65 years old at the start of 2008 and continuously enrolled in fee-for-service parts A and B Medicare coverage for the two years.

We used publicly available claims analysis algorithms to identify patients with episodes of CHF, COPD, and DM on the basis of diagnosis and procedure codes.[13] For each condition, an episode was defined as lasting 365 days and beginning when a patient had an encounter that included one of a set of predefined 'trigger' diagnoses. We identified 98,850 CHF episodes, 147,708 COPD episodes, and 281,584 DM episodes that began during 2008. Because our measurement window was limited to two years, each person had only one episode of each condition; however, patients were permitted to have an episode for each of the conditions we studied (up to 3 episodes). In accordance with the episode algorithms, patients were excluded if they had an inhospital death, left the hospital against medical advice, or had a medical exclusion (*e.g.*, cardiac arrest, HIV, cancer, suicide, end stage renal disease) during the episode. Claims were excluded from episodes if they were irrelevant to the chronic condition (e.g., surgical procedures for which the chronic condition was a comorbidity rather than the primary reason for the procedure). These exclusions accounted for 38% of CHF episodes, 36% of COPD episodes, and 31% of DM episodes. We further excluded an additional 8% of CHF episodes, 12% of COPD episodes, and 10% of DM episodes with <2 outpatient evaluation and management visits (as defined below) due to the inability to construct continuity measures for these individuals. After exclusions, the final analytic cohort included 241,722 unique patients, of whom 53,488 had CHF, 76,520 had COPD, and 166,654 had DM.

This study was approved by the RAND Human Subjects Protection Committee and the Johns Hopkins School of Medicine Institutional Review Board.

Measures

The four continuity measures - the Bice-Boxerman Continuity of Care (COC) Index,[14] Herfindahl Index (HI), usual provider of care (UPC),[15] and Sequential Continuity of Care Index (SECON)[16] —are described in Table 1.

The COC index reflects "the extent to which a given individual's total number of visits for an episode of illness or a specific time period are with a single or group of referred providers."[14] The HI, which is most commonly used in economic analyses of market concentration, is similar to the COC index in that it reflects the extent to which an individual's visits during an episode of care are concentrated with a single or group of providers. Although conceptually similar to the COC index, it is calculated using a different mathematical formula. Both measures sum the squared number of visits to a given providers. UPC reflects the "density" of care, or the extent to which visits are concentrated with a single usual provider or group of providers during an episode.[11] It equals the number of visits to the provider or practice group with the highest number of visits divided by the total number of visits. SECON varies from the others in that it considers the order of visits, not just their concentration or dispersion among providers. It equals the fraction of sequential visits pairs at which the same provider is seen, i.e. same provider being seen at both the previous and current visits.

We limited the calculation of these measures to outpatient evaluation and management visits defined as Berenson-Eggers Type of Service codes M1A, M1B, M4A, M4B, M5C, M5D, and M6. Only a single E&M visit per day for each patient-provider dyad was counted, where

providers were determined using the National Provider Identifier. Visits that were related to complications, hospitalizations, or emergency department visits were excluded from our calculation of the COC index. In addition, we counted only visits to those clinicians that were most likely to be involved in outpatient management for each of the three conditions. For CHF, this included primary care providers (PCPs - general practitioners, family practitioners, internal medicine without subspecialty training, and nurse practitioners), cardiologists, and pulmonologists. For COPD, we included PCPs and pulmonologists; for DM, we included PCPs, cardiologists, endocrinologists, podiatrists, and ophthalmologists. Physician specialty was determined using the specialty code from the Carrier file. With the exception of general practitioners, each specialty class of provider accounted for more than 2% of outpatient E&M visits, and the included providers accounted for 90.6% of total outpatient E&M visits for CHF, 89.6% for COPD, and 86.0% for DM. Practice groups were defined using the tax identification number assigned to each outpatient evaluation and management claim for the above provider types. Each measure was constructed separately using visits to providers and to practice groups.

Analysis

We calculated Pearson correlation coefficients among the four continuity measures at the provider level and the practice level for patients with each chronic disease. We also calculated the correlation between provider-level and practice-level versions of the four measures.

In sensitivity analyses we first excluded patients with perfect continuity or discontinuity when examining the correlations among the measures. Second, we performed principal component analysis to determine the number of domains the continuity measures loaded on. Third, the episode-based algorithms we employed exclude a large portion of claims in order to create relatively homogeneous cohorts. We recalculated continuity measures in which we included all claims from outpatient evaluation and management visits. This included claims that had been previously been deemed by the algorithms to be ‘irrelevant’ and included all specialty types.

RESULTS

Table 2 shows the sample descriptive statistics. For each clinical condition, over half the sample was female and between 10% and 17% was non-white. The median number of outpatient evaluation and management visits during the year-long episode ranged from 5 among patients with COPD to 7 among patients with CHF, with relatively similar interquartile ranges as shown in the table. Appendix Figures 1 and 2 presents the distribution of each continuity measure when calculated at the provider- and practice-levels respectively. A large proportion of patients had perfect continuity (22% to 37% of patients for each measure at the provider-level; 23% to 46% at the practice-level, See Appendix Table 1). Perfect discontinuity was observed in 3% to 5% of patients using the COC and between 6% and 14% of patients with SECON.

Calculated at the level of individual providers, Table 3 shows that the Pearson coefficients of correlations between measures were high (r=0.87 to 0.98) across the four measures and three

conditions with the highest correlations between the HI and UPC (r=0.98 for CHF and COPD, 0.97 for DM; scatterplots are provided in Appendix Figure 3). Correlations between HI and COC were nearly as high (r=0.96 for CHF, COPD, and DM). SECON was somewhat more weakly correlated with the other three measures, although correlation coefficients were still quite high (0.87–0.89 for UPC, 0.87–0.88 for HI, and 0.90–0.92 for COC). Correlations were consistent for all measure dyads across the three chronic conditions studied.

Correlations among the four measures were somewhat lower when the measures were calculated at the practice level compared to the provider level (r=0.75 to 0.98). As with the clinician-level measures, correlations between UPC, HI, and COC were very high (r=0.96 to 0.98), while SECON was somewhat more weakly correlated with the other three measures (r=0.75 to 0.79 for UPC, 0.75 to 0.80 for HI, and 0.78 to 0.82 for COC).

Table 3 also presents the Pearson coefficients of correlation between the provider and practice level versions of the four measures. The provider level and practice level versions of each measure were highly correlated (r=0.77 to 0.92). The correlation between provider and practice level measures was weaker for SECON (r=0.77 for DM, 0.77 for COPD, and 0.83 for DM) compared with the other three measures. Comparing across the four measures and between provider- and group-level versions of the measures, the lowest observed correlation coefficient was 0.65 (provider-level HI and practice group-level SECON).

In sensitivity analyses, we assessed the correlations among measures after we had excluded patients with perfect continuity/discontinuity. Correlations were somewhat weaker than those found in the main analyses, especially between SECON measured at the practice-level and other measures (r≥0.53 with other practice-level measures and r≥0.45 with other provider-level measures, see Appendix Table 2). Using principal component analysis, we found that all four continuity measures appeared to load on a single component when run at the provider- or practice-levels for each clinical condition (e.g., Eigenvalues were greater than 1 for a single component and less than 1 with 2 or more components). When we included all outpatient evaluation and management visits when calculating the continuity measures, we continued to observe high correlations among all measures (Appendix Table 3).

DISCUSSION

We assessed correlations among the results of four different claims-based measures of care continuity during episodes of care for three chronic conditions among Medicare beneficiaries. Despite conceptually distinct constructs represented by the four measures, our analysis shows that results based on each of the four measures are highly correlated within episodes of care. Further, all four measures yielded similar results whether the unit of analysis was a visit to an individual clinician or a visit to a practice group. Correlations were especially high among the Bice-Boxerman Continuity of Care Index, Herfindahl Index, usual provider of care, and somewhat lower with SECON.

Our results may be of interest to those designing programs to measure care coordination using available claims-based measures within episodes of care. Specifically, the choice of

measure may have little impact on inferences that would be drawn about the extent of care continuity. Furthermore, the correlation between measure results at the physician or practice group level similarly suggests that inferences may be insensitive to this choice. The high correlations across the measures may make it easier to compare results across studies that employ different continuity measures. Importantly, we did not assess whether and to what extent each measure independently predicts outcomes, and it is possible that different measures provide explanatory power for particular outcomes.

The high correlations suggest that the choice of measures may be driven by practical and/or conceptual concerns. Practical considerations entail availability of data (e.g. dates or order of visits are required for SECON) and ease of programming. Conceptual concerns include whether a research is interested in care concentrated among a single doctor (as measured the Usual Provider of Care Index), the dispersion of care among all of a patient's providers (Bice-Boxerman Continuity of Care Index and the Herfindahl Index), or the handoffs between providers (SECON). The conceptual distinction between SECON and the other measures appears most important empirically as the correlations were somewhat lower, especially when measured at the practice-level.

The claims-based measures we studied have previously-described limitations. The four measures are all constructed on the basis of the patterns of patient encounters to providers during a time period. As such, the measures offer limited information about important constructs of coordination such as "interpersonal continuity" between clinicians and patients, or the coordination activities that may occur outside of visits between clinicians or between clinicians and patients.[12] These other constructs may be better captured by patient or provider surveys or the use of other methods. Second, episode-based frameworks exclude a large proportion of patients and claims in order to create more homogenous cohorts. Our results may not be generalizable to other settings. Third, in our main analysis, we limited the list of included clinicians to those most likely to be involved in coordination for a given episode of care and we focused on assessment of outpatient visits. This may have led to the exclusion of some clinicians who may be important for coordinating care for particular patients. Our sensitivity analysis which included all providers for outpatient visits found similar results. Including inpatient care and the transitions between outpatient and inpatient care may have altered the correlations we observed. Finally, the generally low number of visits (median 5 to 7 across the three episodes) may have limited our ability to see variation in continuity. The continuity measures may be especially salient to patients who have a large number of visits and for whom the need for coordination may be highest.

Notwithstanding these important limitations, claims-based measures are feasible to implement comprehensively and efficiently for large populations of patients. Such measures may be used to compare the degree of care continuity between subpopulations of interest and to identify those beneficiaries with the lowest levels of continuity. The high correlations among the four measures we considered, whether derived at the provider or practice level, indicates that the choice of measures can be driven by the intent of a measure.

Acknowledgments

This work was supported by the Aetna Foundation. Dr. Pollack's salary is supported by the National Cancer Institute (NCI) and Office of Behavioral and Social Sciences (K07 CA151910).

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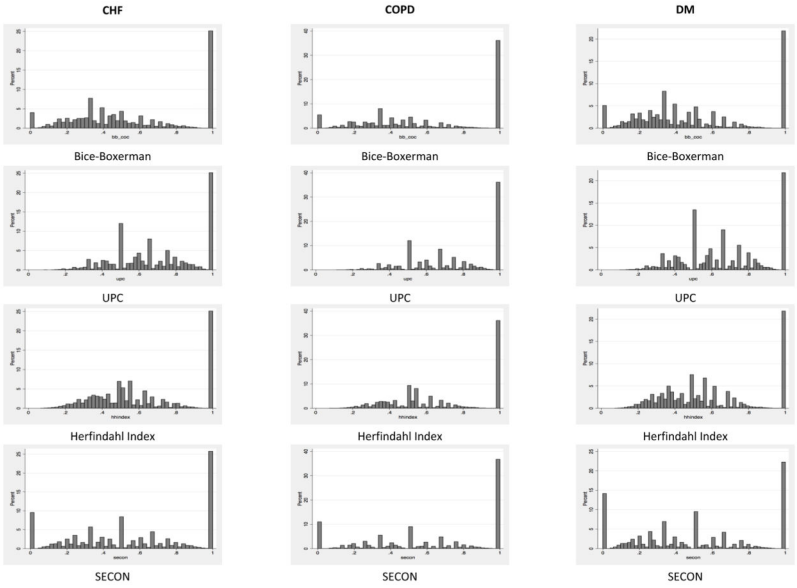
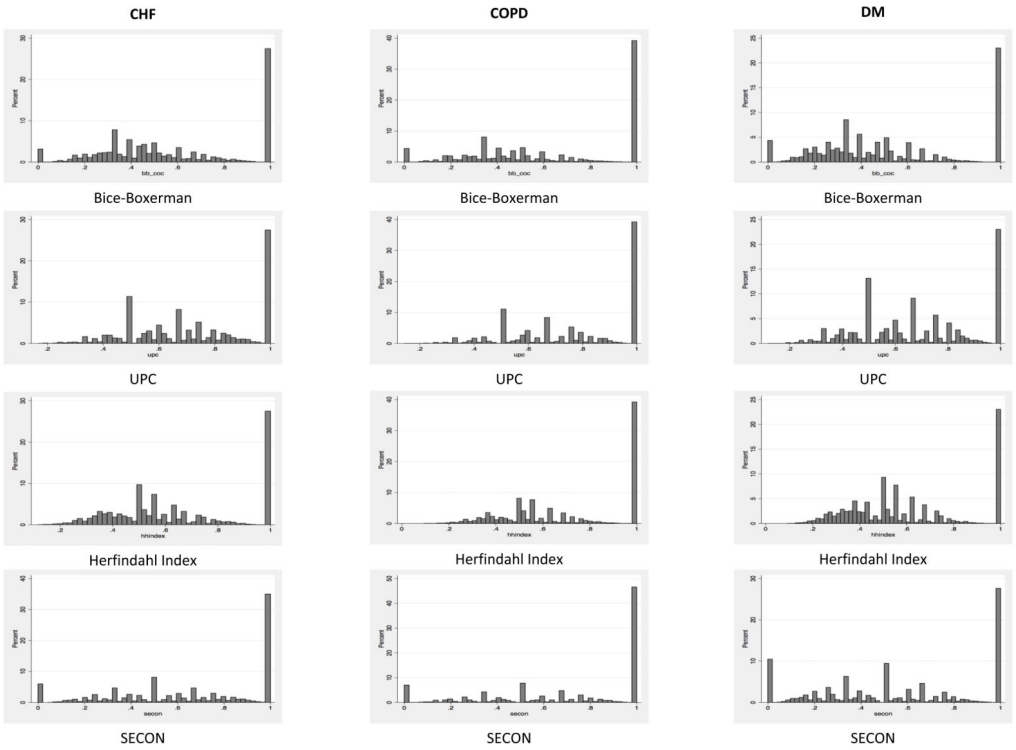
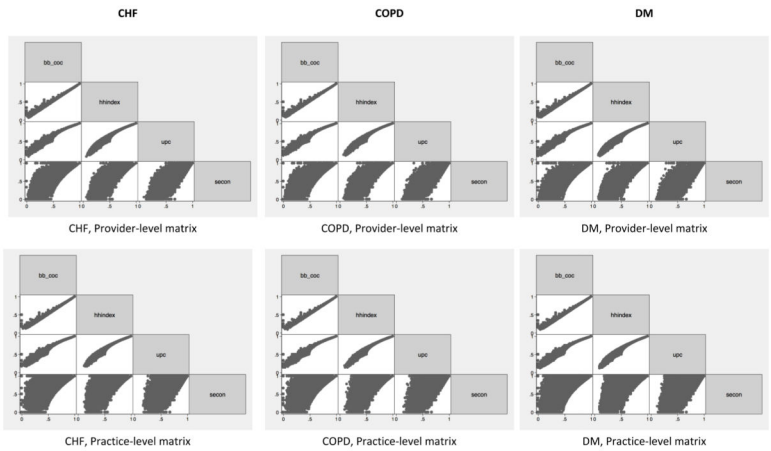


Appendix Figure 1.
Distributions of Claims-Based Continuity Measures at the Provider Level



Appendix Figure 2.
Distributions of Claims-Based Continuity Measures at the Practice Level



Appendix Figure 3.
Correlation-matrices between continuity measures

Table 1

Summary of Claims-Based Coordination Measures

Measure	Formula	Concept Represented
Bice-Boxerman Continuity of Care Index (COC)	$\frac{(\sum_{i=1}^{p} n_i^2)-n}{n(n-1)}$	Degree of coordination required between different providers during an episode
Herfindahl Index (HI)	$\sum_{i=1}^{p}\left(\frac{n_i}{n}\right)^2$	Degree of coordination required between different providers during an episode
Usual Provider of Care (UPC)	$max\left(\frac{n_i}{n}\right)$	Concentration of care with a primary provider
Sequential Continuity Index (SECON)	$\frac{\sum_{j=1}^{n-1} c_j}{n-1}$	Number of handoffs of information required between providers

p = total number of providers

n = total number of visits during episode

n_i = number of visits to provider i

c_j = indicator of sequential visits to same providers; equal to 1 if visits j and j+1 are to the same provider, 0 otherwise

Table 2

Characteristics of Medicare beneficiaries with 12-month episodes of care for CHF, COPD, and DM in 2008–09

	CHF	COPD	DM
Total (%)	53488 (100)	76520 (100)	166654 (100)
Age			
65–74	15985 (30)	33418 (44)	80262 (48)
75–84	21851 (41)	30382 (40)	64136 (38)
85+	15652 (30)	12720 (17)	22256 (13)
Gender			
Female	28653 (54)	41685 (54)	88565 (53)
Male	24835 (46)	34835 (46)	78089 (47)
Race/ethnicity			
White	46405 (87)	68637 (90)	137648 (83)
Black	4999 (9)	5001 (7)	18700 (11)
Other/Unknown	2084 (4)	2882 (3)	10306 (6)
Census regions			
Midwest	13606 (25)	19269 (25.18)	40164 (24)
Northeast	11075 (21)	14314 (18.71)	34131 (21)
South	21025 (39)	32109 (41.96)	66934 (40)
West	7554 (14)	10590 (13.84)	24123 (14)
Other	228 (0)	238 (0.31)	1299 (1)
Median ZCTA Household Income, 2000 ($) (IQR)	39864 (34778, 47603)	39685 (34623, 46956)	40029 (35042, 48397)
In multiple episodes (DM, CHF, COPD)	31,071 (58%)	32,485 (42%)	39,225 (24%)
Median number of E&M visits per episode (IQR) *	7 (4, 11)	5 (3, 8)	6 (4, 10)

*visits to primary care physicians and other frequent providers.

CHF = congestive heart failure. COPD = chronic obstructive pulmonary disease. DM = diabetes mellitus. ZCTA = zip code tabulation area. IQR = interquartile range. E&M = evaluation and management.

Table 3

Correlation Between Four Claims-Based Continuity Measures at the Provider Level and the Practice Group Level, Medicare Beneficiaries with CHF, COPD, and DM (Pearson correlation coefficients)

CHF

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.96	1.00						
UPC	0.96	0.98	1.00					
SECON	0.90	0.87	0.87	1.00				
PRACTICE GROUP LEVEL								
COC	0.87	0.84	0.84	0.80	1.00			
HI	0.85	0.89	0.86	0.77	0.97	1.00		
UPC	0.84	0.86	0.87	0.77	0.96	0.98	1.00	
SECON	0.68	0.65	0.65	0.77	0.78	0.75	0.75	1.00

COPD

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.96	1.00						
UPC	0.97	0.98	1.00					
SECON	0.92	0.88	0.89	1.00				
PRACTICE GROUP LEVEL								
COC	0.87	0.85	0.85	0.81	1.00			
HI	0.85	0.89	0.87	0.79	0.97	1.00		
UPC	0.85	0.87	0.88	0.79	0.97	0.98	1.00	
SECON	0.70	0.69	0.69	0.77	0.81	0.78	0.78	1.00

DM

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.96	1.00						
UPC	0.95	0.97	1.00					
SECON	0.91	0.87	0.87	1.00				
PRACTICE GROUP LEVEL								
COC	0.91	0.87	0.87	0.84	1.00			
HI	0.88	0.92	0.90	0.81	0.96	1.00		
UPC	0.87	0.89	0.91	0.81	0.96	0.97	1.00	
SECON	0.75	0.73	0.72	0.83	0.82	0.80	0.79	1.00

CHF=congestive heart failure. COPD=chronic obstructive pulmonary disease. DM=diabetes mellitus. COC = Bice-Boxerman Continuity of Care index. HI = Herfindahl Index. UPC = Usual Provider of Care index. SECON = Sequential Continuity index.

All Pearson correlation coefficients are statistically significant at the $p<0.0001$ level.

Med Care. Author manuscript; available in PMC 2017 May 01.

Appendix Table 1

Percent of patients with perfect continuity/discontinuity

	CHF n=53,488		COPD n=76,520		DM n=166,654	
	Provider-level	**Practice-level**	**Provider-level**	**Practice-level**	**Provider-level**	**Practice-level**
BB						
discontinuity	4%	3%	5%	4%	5%	4%
continuity	25	27	36	39	22	23
HH						
discontinuity	0	0	0	0	0	0
continuity	25	27	36	39	22	23
UPC						
discontinuity	0	0	0	0	0	0
continuity	25	27	36	39	22	23
SECON						
discontinuity	10	6	11	7	14	10
continuity	26	35	37	46	22	28

Appendix Table 2

Correlations Between Claims-Based Coordination Measures. Excluding instances where there is perfect continuity or discontinuity.

CHF

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.96	1.00						
UPC	0.94	0.97	1.00					
SECON	0.72	0.72	0.70	1.00				
PRACTICE GROUP LEVEL								
COC	0.82	0.76	0.75	0.59	1.00			
HI	0.80	0.81	0.79	0.61	0.96	1.00		
UPC	0.78	0.77	0.82	0.59	0.94	0.96	1.00	
SECON	0.48	0.45	0.45	0.79	0.57	0.56	0.55	1.00

COPD

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.95	1.00						
UPC	0.93	0.96	1.00					
SECON	0.69	0.70	0.66	1.00				
PRACTICE GROUP LEVEL								
COC	0.85	0.78	0.77	0.59	1.00			
HI	0.81	0.84	0.81	0.61	0.95	1.00		
UPC	0.79	0.79	0.85	0.58	0.93	0.96	1.00	
SECON	0.49	0.47	0.46	0.82	0.56	0.55	0.53	1.00

DM

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.96	1.00						
UPC	0.94	0.97	1.00					
SECON	0.72	0.74	0.71	1.00				
PRACTICE GROUP LEVEL								
COC	0.87	0.82	0.81	0.65	1.00			
HI	0.84	0.88	0.85	0.67	0.96	1.00		
UPC	0.82	0.83	0.88	0.65	0.94	0.97	1.00	
SECON	0.54	0.54	0.53	0.84	0.61	0.62	0.60	1.00

Appendix Table 3

Correlations Between Claims-Based Coordination Measures. Claims-based measures include all claims and types of providers for patients in a given episode of care.

CHF

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.97	1.00						
UPC	0.95	0.97	1.00					
SECON	0.88	0.85	0.84	1.00				
PRACTICE GROUP LEVEL								
COC	0.92	0.90	0.88	0.82	1.00			
HI	0.90	0.94	0.90	0.80	0.97	1.00		
UPC	0.88	0.90	0.92	0.79	0.95	0.97	1.00	
SECON	0.68	0.67	0.66	0.79	0.75	0.73	0.72	1.00

COPD

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.97	1.00						
UPC	0.95	0.97	1.00					
SECON	0.89	0.86	0.84	1.00				
PRACTICE GROUP LEVEL								
COC	0.93	0.92	0.90	0.83	1.00			
HI	0.91	0.95	0.92	0.81	0.97	1.00		
UPC	0.89	0.92	0.94	0.80	0.95	0.97	1.00	
SECON	0.71	0.70	0.69	0.81	0.77	0.75	0.74	1.00

DM

	PROVIDER LEVEL				PRACTICE GROUP LEVEL			
	COC	**HI**	**UPC**	**SECON**	**COC**	**HI**	**UPC**	**SECON**
PROVIDER LEVEL								
COC	1.00							
HI	0.96	1.00						
UPC	0.95	0.97	1.00					
SECON	0.89	0.85	0.84	1.00				
PRACTICE GROUP LEVEL								
COC	0.93	0.90	0.89	0.84	1.00			
HI	0.90	0.95	0.92	0.81	0.96	1.00		
UPC	0.89	0.92	0.94	0.80	0.95	0.97	1.00	
SECON	0.71	0.70	0.68	0.82	0.77	0.75	0.74	1.00