The Method for Performance Measurement Matters: Diabetes Care Quality as Measured by Administrative Claims and Institutional Registry

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Objectives. Performance measurement is used by health care providers, payers, and patients. Historically accomplished using administrative data, registries are used increasingly to track and improve care. We assess how measured diabetes care quality differs when calculated using claims versus registry.

Data Sources/Study Setting. Cross-sectional analysis of administrative claims and electronic health records (EHRs) of patients in a multispecialty integrated health system in 2012 ($n = 368,883$).

Study Design. We calculated percent of patients attaining glycohemoglobin <8.0 percent, LDL cholesterol <100 mg/dL, blood pressure $<140/90$ mmHg, and nonsmoking (D4) in cohorts, identified by Medicare Accountable Care Organization/Minnesota Community Measures (ACO-MNCM; claims-based), Healthcare Effectiveness Data and Information Set (HEDIS; claims-based), and registry (EHR-based).

Data Collection/Extraction Methods. Claims were linked to EHR to create a dataset of performance-eligible patients.

Principal Findings. ACO-MNCM, HEDIS, and registry identified 6,475, 6,989, and 6,425 measurement-eligible patients. Half were common among the methods; discrepancies were due to attribution, age restriction, and encounter requirements. D4 attainment was lower in ACO-MNCM (36.09 percent) and HEDIS (37.51 percent) compared to registry (43.74 percent) cohorts.

Conclusions. Registry- and claims-based performance measurement methods identify different patients, resulting in different rates of quality metric attainment with implications for innovative population health management.

Key Words. Performance measures, population health, registry, quality improvement

Improving the quality of chronic disease care is contingent, in part, on accurately measuring and reporting current performance. For patients with diabetes, one of the most prevalent and costly chronic conditions in the United States (CDC 2011), quality care has been defined by dichotomous measures of glucose, blood pressure (BP), and lipid control and recommendations for smoking cessation, eye and foot examinations, nephropathy screening, and diabetes self-management and nutrition education (Fleming et al. 2001). Metrics currently used for pay-for-performance reimbursement and public reporting are based on Healthcare Effectiveness Data and Information Set (HEDIS) measures developed by the National Committee for Quality Assurance (NCQA) (2013): glycosylated hemoglobin (HbA_{1c}) <8.0 percent, low-density lipoprotein cholesterol (LDL-C) <100 mg/dL, BP <140/90 mmHg, nonsmoking, and aspirin therapy in the presence of ischemic vascular disease (NCQA 2009, 2013a). This composite measure has been adopted by the Centers for Medicare and Medical Services (CMS) as a performance measure for Medicare Accountable Care Organizations (ACOs) (2012) and is often used by clinicians and health systems striving to improve the quality of diabetes care.

Central to any performance measure is an accurate and efficient methodology for identifying the appropriate patient population (denominator) to which the measure (numerator) is to be applied. Currently, CMS and private payers apply these metrics to adults between 18 and 75 years identified from administrative data (NCQA 2009, 2013a,c,d). While HEDIS is a hybrid measure that uses a combination of administrative, pharmacy, and electronic health record (EHR) clinical data, it still relies solely on administrative and pharmacy data to identify patients eligible for performance measurement, while EHR data are used to document attainment of recommended targets. Moreover, such hybrid methods were found to perform only minimally better than methods that rely only on claims (O'Connor et al. 1998; Solberg et al. 2006). Importantly, there is invariably a delay between a patient encounter and ascertainment of performance, and providers are often left unaware of the

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results, such that this information cannot be used in real time to benefit individual patients and providers. A clinician may be held responsible for a patient's outcome and process measures even if she is not providing ongoing diabetes care. The latter is most likely to occur in a referral practice, where patients are seen intermittently for consultation and receive their primary care elsewhere. In such situations, the totality of the patient's care may not be known to the reporting institution, resulting in report of incomplete or inaccurate data; and patients may be inadvertently attributed to institutions providing sporadic care.

Reliance on administrative data from clinical encounters to measure performance can underestimate the extent of delivered care, or, conversely, promote redundancy and overutilization. Services may be missed if they are incorrectly coded or are delivered by a noneligible provider or outside the reporting practice (Walsh et al. 2002). Patients managed by an eHealth coordinated care program may be excluded from the denominator because they do not generate a claim, although their diabetes is actively managed in an individualized and cost-effective way. Claims-based performance measurement may penalize innovative care delivery approaches that may improve patient outcomes, decrease patient burden, maximize efficiency, and reduce health care costs.

Clinical registries provide an alternative method of tracking patients and are becoming increasingly common as health systems and providers use them internally to monitor performance, recognize patients in need of services, individualize interventions, and guide quality improvement. Because patients can be entered into registries as a result of diagnoses documented by their providers irrespective of the number, time, or focus of clinical encounters, registries may be a more accurate method of patient attribution. In 2013, CMS permitted qualifying registries to be used for quality measurement and reporting as part of the Physician Quality Reporting System (2013b), although currently approved registries are required to report measures on at least three clinical domains (e.g., are not single-disease registries) and are maintained by commercial vendors (2014). We therefore compared diabetes performance in our integrated health care delivery system using the denominator definitions provided by CMS ACOs (adopted from Minnesota Community Measures [MNCM], and heretofore referred to as ACO-MNCM) (2012, 2013); HEDIS (NCQA 2009); and our institutional diabetes registry. While this registry is specific to our institution, because there are no standardized criteria for registry creation and maintenance, it serves as an example of how any institutional registry may differ from the common claims-based methods.

METHODS

Study Design

This is a cross-sectional study conducted at Mayo Clinic (Rochester, MN, USA), a multispecialty integrated delivery system providing comprehensive medical care through outpatient, inpatient, and eHealth platforms to a diverse population of local, regional, national, and international patients. It includes eight primary care clinics (internal medicine and family medicine), serving local and regional patients, and an endocrinology referral practice. During the 2012 calendar year, Mayo Clinic provided care to 368,883 patients, all of whom were included in the population subject to ACO-MNCM, HEDIS, and registry criteria for eligible patient identification. This study was approved by the Mayo Clinic Institutional Review Board.

Cohort Assembly (Table 1)

Registry. Patients who are empaneled to a primary care provider (PCP) are automatically included in the diabetes registry when a diagnosis of diabetes (ICD-9-CM code 250.xx) is entered into the clinical problem list by a PCP; this is not predicated on a face-to-face clinical encounter. Empanelment is the process of systematically linking patients with a specific provider to facilitate continuity of their relationship and assign responsibility for that patient to an identifiable provider; it is a key component of population health management and a defining feature of the patient-centered medical home (2007; Coleman and Phillips 2010; Wagner et al. 2012). Patients are automatically removed from a panel after 3.5 years without any contact with the health care system. Use of EHR clinical problem lists to identify patients with diabetes was previously shown to have high positive predictive value (Tang et al. 2007). The registry is updated weekly; patients are entered into the registry once inclusion criteria are met, and they are removed if they are no longer empaneled or the diagnosis of diabetes is removed from the active problem list. The registry includes identifiable demographic and clinical information pertinent to performance measurement. All patients in the registry as of December 31, 2012, were included in this cohort.

ACO-MNCM. Medicare ACO performance metrics for diabetes were adopted from MNCM (2012) and were identified from the 2013 submission of 2012 data to MNCM, using ICD-9-CM codes from Mayo Clinic billing (ad-

Table 1: Comparison of Three Different Methods of Identifying People with Diabetes Eligible for Performance Measurement and Reporting

	<i>ACO-MCCM (2012, 2013)</i>	<i>Registry</i>	<i>HEDIS (NCQA 2009)[†]</i>
Inclusion criteria*	18–75 years old on January 1 of the measurement year Qualifying ICD-9-CM codes 250.xx ≥1 face-to-face clinical encounter for any cause during the measurement year ≥2 face-to-face clinical encounters for diabetes during the measurement year and year prior Diagnosis by, and encounter with, an eligible provider [‡] in an eligible specialty [§]	≥18 years old on the date of diabetes diagnosis entry Empaneled to a PCP Qualifying ICD-9-CM codes 250.xx Diagnosis by PCP ≥1 ICD-9-CM for diabetes during measurement year; not necessarily as part of a face-to-face encounter	18–75 years old on December 31 of the measurement year. Qualifying ICD-9-CM codes 250.xx, 357.2, 362.0, 366.41, 648.0. [¶] One of the following: (1) ≥2 face-to-face clinical encounters for diabetes during the measurement year or year prior. (2) ≥1 acute face-to-face clinical encounter (inpatient or emergency department) for diabetes during the measurement year or year prior. Diagnosis by, or encounter with, any provider or any specialty
Exclusion criteria [†]	Nursing home resident Enrolled in hospice Pregnancy Death	Removed from primary care panel after 3.5 years of inactivity (face-to-face or other	Enrollment less than 45 days during the measurement period
Source of data	ICD-9-CM diagnoses from internal administrative (billing) data	ICD-9-CM diagnoses entered by PCPs into the EHR problem list	ICD-9-CM diagnoses from internal administrative (billing) data
Issuing agency	State of Minnesota/CMS	Institution	NCQA

*All inclusion criteria must be met, unless stated otherwise.
[†]Exclusion criteria can be present at any time during the measurement period to exclude the patient from the cohort.
[‡]Eligible provider is either a Medical Doctor, Doctor of Osteopathy, Physician Assistant, or Nurse Practitioner.
[§]Eligible specialties are family medicine, internal medicine, geriatric medicine, and endocrinology.
[¶]Pharmacy records are part of the formal HEDIS criteria, but they were not used to identify patients in this study if none of the other criteria were met.
^{||}Only two patients in the HEDIS cohort did not have a 250.xx diagnosis: one each of 648.01 and 648.03.
 ACO, Accountable Care Organization; CMS, Centers for Medicare and Medicaid Services; EHR, electronic health record; HEDIS, Healthcare Effectiveness Data and Information Set; MNM, Minnesota Community Measures; NCQA, National Committee for Quality Assurance; PCP, primary care provider.

ministrative) data. We refer to this method as ACO-MNCM throughout the manuscript as the criteria for Medicare ACO reporting are the same as for MNCM (2012, 2013).

HEDIS. Patients meeting HEDIS criteria for inclusion were identified using the HEDIS 2012 definition (NCQA 2009), using ICD-9-CM codes from Mayo Clinic billing (administrative) data. Pharmacy data were not used as it is not consistently available for the whole study population, and use of claims data only was previously shown to have high sensitivity, specificity, and positive predictive value in the primary care setting (O'Connor et al. 1998).

Outcomes

The primary outcome was the number and percent of patients who met all of the following targets (D4) as the last entry during the measurement period, extracted from the EHR: HbA_{1c} <8.0 percent; LDL-C <100 mg/dL; BP <140/90 mmHg; and documentation that the patient is not a tobacco user. The method of clinical data extraction was identical for all three cohorts; differences in D4 attainment reflect differences in patients deemed eligible for performance evaluation using the three methods described above. Missing values were analyzed as not meeting criteria, consistent with performance measurement specifications (NCQA 2009, 2013a).

Independent Variables

Patient demographics were extracted from the EHR. The Charlson comorbidity index (CCI) for the 2012 calendar year was calculated using ICD-9-CM codes in claims data. The CCI is a widely used measure that weighs comorbid conditions by the strength of their association with 1-year mortality (Charlson et al. 1994; de Groot et al. 2003); it has been validated for use in diabetes (McEwen et al. 2007). High comorbidity and limited life expectancy were defined by CCI ≥ 4 based on previously published data (McEwen et al. 2012).

Sensitivity Analyses

To evaluate the impact of patient age and requirement for clinical encounters, we performed analyses comparing three modified registries to ACO-MNCM: (R1) registry patients <75 years old as of January 1, 2012; (R2) registry patients with ≥ 2

face-to-face encounters in primary care between January 1, 2011, and December 31, 2012; and (R3) registry patients meeting both age and encounter restrictions.

Statistical Analysis

Descriptive statistics were calculated for each cohort as frequencies or means (SD). Because the samples in each cohort are not independent, standard statistical tests cannot be applied for comparison. A qualitative interpretation of the data is therefore presented. Statistical analysis was performed using SAS 9.2 (SAS Institute, Cary, NC, USA).

RESULTS

Patient Characteristics by Sampling Cohort

There was substantial variability in the number of patients meeting inclusion criteria for performance measurement by ACO-MNCM, HEDIS, and registry definitions (Table 2; Figure 1). As shown in Figure 1, only 3,250 patients met inclusion criteria by all three definitions (R+H+A). Additional 2,365 patients were included in ACO-MNCM and HEDIS (A+H), but not the registry; and 2,786 were in the registry (R), but not in ACO-MNCM or HEDIS.

Patients included for ACO-MNCM reporting were younger than those included in the registry, with mean age 59.38 years (SD: 11.96) in the ACO-MNCM cohort compared to 64.02 years (SD: 14.77) in the registry cohort; $p < .001$. HEDIS criteria identified even younger patients; mean age 58.79 years (SD: 12.29); $p = .005$ when compared to the ACO-MNCM cohort. There was no difference in mean CCI, or proportion of individuals with $CCI \geq 4$, in the registry and HEDIS cohorts as compared to the ACO-MNCM cohort (Table 2).

Nearly all patients included in the registry received their primary care at our institution, and 6,267 (89.67 percent) had at least one encounter with a PCP during the 2012 measurement year (Table 2). In contrast, only 3,723 of 6,475 (57.50 percent) individuals in the ACO-MNCM cohort were empaneled, and the remainder was seen only in the endocrinology referral practice with the exception of one person who was seen in a different subspecialty practice. Of those with an identifiable PCP, 3,496 (93.90 percent) had at least one encounter with primary care during the measurement year. Not being empaneled with a PCP was not the sole reason behind the discrepancy between the ACO-MNCM and registry cohorts, as 251 (3.43 percent) ACO-MNCM patients were empaneled with a PCP but were still excluded from the registry, likely because the diabetes diagnosis was not confirmed by a PCP.

Table 2: Patient Characteristics and Diabetes Care Quality as Measured Using the ACO-MNCM, Registry, and HEDIS Methods

	<i>ACO-MNCM</i>	<i>Registry</i>	<i>HEDIS</i>
Patient, <i>N</i>	6,475	6,989	6,425
Age, mean (SD)	59.38 (11.96)	64.02 (14.11)	58.78 (12.29)
Age ≥75 years, <i>N</i> (%)	—	1,800 (25.75)	—
CCI, mean (SD)	1.94 (1.64)	1.93 (1.73)	1.96 (1.70)
CCI ≥4, <i>N</i> (%)	783 (12.09)	903 (12.92)	806 (12.54)
Gender, female, <i>N</i> (%)	2,834 (43.77)	3,229 (46.20)	2,841 (44.22)
Provider type			
Internal medicine	2,063 (31.86)	4,079 (58.36)	2,426 (37.76)
Family medicine	1,660 (25.64)	2,905 (41.57)	1,860 (28.95)
Endocrinology referral practice	2,751 (42.49)	0 (0.00)	2,127 (33.11)
Unpaneled/other	1 (0.02)	5 (0.07)	12 (0.19)
Primary care visits			
Patients with visits, <i>N</i> (%)	3,496 (53.99)	6,267 (89.67)	3,854 (59.98)
Number of visits, mean (SD)*	4.00 (3.31)	3.92 (3.42)	3.95 (3.27)
Endocrinology care			
Patients with visits, <i>N</i> (%)	3,189 (49.25)	1,259 (18.01)	2,849 (44.34)
Number of visits, mean (SD)*	2.27 (1.44)	2.24 (1.50)	2.34 (1.50)
Quality measures			
HbA _{1c} <8.0%	4,542 (70.15)	5,406 (77.35)	4,519 (70.33)
LDL <2.59 mmol/L	4,518 (69.78)	5,261 (75.28)	4,559 (70.96)
BP <140/90 mmHg	5,083 (78.50)	5,544 (79.32)	5,078 (79.04)
Tobacco free	5,266 (81.33)	6,087 (87.09)	5,354 (83.33)
Measures 1–3	2,725 (42.08)	3,393 (48.55)	2,753 (42.85)
All four measures	2,337 (36.09)	3,057 (43.74)	2,410 (37.51)

Notes. The same population was subjected to patient selection for eligibility criteria and application of diabetes performance measurement as specified by the ACO-MNCM, registry, and HEDIS methods. Internal medicine practices include preventive medicine.

*Number of visits per year for those with visits.

ACO-MNCM, Accountable Care Organization – Minnesota Community Measures; HEDIS, Healthcare Effectiveness Data and Information Set.

Similarly, only 4,286 of 6,425 (66.71 percent) individuals identified by HEDIS criteria had an identified PCP; all but 10 of the remainder received care within the endocrinology referral practice. Of those with a PCP, 3,854 (89.92 percent) had a clinical encounter with primary care in 2012. There were 318 (4.34 percent) HEDIS patients who were empaneled with a PCP but were not included in the registry.

Measured Performance Differs by Cohort Definition

A much higher proportion of registry patients met the D4 measure as compared to the ACO-MNCM cohort; 43.74 percent versus 36.09 percent, as shown in

Figure 1: Diabetes Population, Overlap, and Performance Measures Based on Each of the Attribution Methods. The Same Population Was Subjected to Patient Selection for Eligibility Criteria and Application of Diabetes Performance Measurement as Specified by ACO-MNCM (A), HEDIS (H), or Registry (R)

Notes. Displayed are the total number of patients per category and percent of patients in each category meeting the composite performance diabetes measure.

Table 2. There was no difference in percent of patients meeting the D4 between those identified by HEDIS (37.51 percent) and ACO-MNCM. Empaneled patients within both ACO-MNCM and HEDIS cohorts had markedly higher rates of achieving the D4 compared to patients who were not empaneled. In the ACO-MNCM cohort, 42.40 percent of the 3,724 empaneled patients, and 27.59 percent of the 2,751 nonempaneled patients achieved the D4. Similarly, in the HEDIS cohort, 41.81 percent of the 4,298 empaneled patients and 28.91 percent of the 2,127 nonempaneled patients achieved the D4.

Effects of Age and Encounter Restrictions on Measured Performance

Because the registry does not exclude empaneled patients on the basis of age or face-to-face encounters, we conducted three sensitivity analyses applying the same age and encounter restrictions as ACO-MNCM to the registry popu-

lation (Table S1). Exclusion of patients under 75 years from the registry resulted in fewer patients attaining the D4 compared to the complete registry, though still more than in the ACO-MNCM. However, exclusion of patients without the requisite two clinical encounters did not alter measured D4 attainment.

DISCUSSION

ACO-MNCM and HEDIS methods are used for performance-based reimbursement and public reporting of diabetes care quality; they rely on administrative data to identify the eligible population whose outcome and process measures are to be assessed. However, because of the delay in claims availability and concerns about patient attribution, providers and health systems increasingly rely on registries to track clinical practice, guide delivery of health services, and identify patients in need of interventions. Use of disease-specific registries has been shown to improve clinical outcomes (Jaffe et al. 2013), but there are also potential concerns about data integrity, transparency, and manipulation. To demonstrate the degree to which the method of performance measurements affects measured performance, our study found substantial differences in percent D4 attainment among primary care patients identified from a single pool of patients served by an integrated health care delivery system that was dependent on the method chosen to measure it. Only half of patients in each cohort were common between the three methods, and measured D4 attainment was 36.09 percent among patients submitted for public reporting and CMS by ACO-MNCM criteria, 37.51 percent among patients identified by HEDIS criteria, and 43.74 percent among patients known to PCPs and included in the registry. While seemingly minor, such differences can have substantial impact on reimbursement, patient perception, and provider practice. Better standardization and transparency of performance evaluation methods is therefore needed, as well as careful consideration of whose performance should ultimately be measured and reported.

There are several reasons for the observed discrepancies between claims-based and registry-based performance evaluation methods. The first stems from their patient attribution methods. Indeed, 42.49 percent of ACO-MNCM and 33.11 percent of HEDIS cohorts were only seen in the endocrinology referral practice and had established primary care elsewhere; the registry only included patients empaneled to primary care. Specialty clinic patients may differ from patients managed in primary care (Chin, Zhang, and

Merrell 2000; Lafata et al. 2001; Greenfield et al. 2002; De Berardis et al. 2004), making direct comparisons of clinical outcome measures difficult. In a fragmented health care delivery system where patients seen in a referral practice have PCPs elsewhere, outcomes documented by either the specialist or the PCP may also be incomplete. Moreover, patients managed by noneligible specialty providers, for example gynecologists or cardiologists, should not be excluded from performance measurement if these providers are responsible for patients' primary care.

Use of administrative data to identify patients may discourage practices providing nonvisit care, as claims-based methods such as ACO-MNCM and HEDIS are predicated on face-to-face encounters that can generate a claim, while registries can include patients based on EHR without relying on claims. This is another reason for the observed differences in patients included in the claims-based versus registry cohorts, as 17.37 percent of registry patients did not have the requisite ≥ 2 face-to-face encounters. Empanelment is the basis for population health management (2007; Coleman and Phillips 2010; Wagner et al. 2012) as it seeks to ensure that all established patients receive optimal care regardless of whether they have face-to-face visits. Payers are beginning to recognize the importance of improved patient tracking and care coordination, and the potential role of nonvisit care in chronic disease management, as exemplified by the recently launched CMS pilot Comprehensive Primary Care Initiative and the introduction of a new chronic care management fee to the Medicare Physician Fee Schedule in 2015 (CMS 2015).

Other patients included in the registry but excluded from both ACO-MNCM and HEDIS were 75 years or older during the measurement year. While exclusion of such patients was designed to minimize risk of potentially inappropriate intensive treatment among older adults who are more likely to have multiple comorbid conditions or other contraindications to intensive therapy, it also risks excluding healthy elderly with longer life expectancies who would still benefit from standard treatment. Excluding patients based on comorbidity or contraindications to intensive therapy (e.g., documented hypoglycemia in the setting of intensive glycemic control; or hypotension in the setting of intensive BP control) is an alternative approach. There were also 718 registry patients who were excluded from ACO-MNCM and HEDIS despite being younger than 75 years and having ≥ 2 clinical encounters, which suggests that the diagnosis of diabetes was present in their EHR but not in claims, such that the different inclusion/exclusion criteria do not account for the entirety of observed differences in measured performance. Referral bias, incomplete outcome data, different patient attribution methods, and the

potential for “missed” patients may all explain why empaneled ACO-MNCM and HEDIS patients had much higher rates of D4 attainment than nonempaneled patients.

A limitation of this study is that most patients served by our eight internal medicine and family medicine primary care clinics were privately or publically insured, with fewer socioeconomic barriers to care than patients in underserved areas. Yet the primary aim of our study was not the quality of diabetes care, but rather the means of measuring it, and this should not be affected by the patient population being served. It is possible that smaller health systems without a significant referral base will not have similar discrepancies, but further research is needed to confirm this. This was a single health system study, and due to lack of standardized criteria for registry creation and quality assurance, registries maintained by other institutions may differ in their technical specifications and therefore produce different results. However, registries generally include patients who are empaneled to, or are actively managed by, a practice rather than those who have generated a claim. Thus, irrespective of the exact empanelment criteria, empaneled patients will differ from those identified using administrative claims and will have different aggregate performance on internal and publically reported quality metrics. Use of standardized registries, or hybrid approaches that combine registries and claims data sources, for performance measurement and reporting may therefore be more accurate representations of individual patient’s health and the provider’s care.

The demonstrated differences in measured performance have important implications for health systems, payers, and the public. Providers rely on metrics to identify patients in need of interventions and to develop quality improvement programs. Health systems need accurate information on care quality and number of patients in need of services. Payers use care quality for performance-based reimbursement and coverage decisions. The public needs reliable information on the care they can expect to receive from their providers and practices. Performance measurement infrastructure would be significantly advanced by the development of standard measurement and reporting methods, whether through standardized registry methods or hybrid approaches including both claims and registries. Understanding the discrepancies and limitations of claims- and registry-based performance measurement is therefore essential first step to designing accurate, transparent, and equitable performance metrics, and thereby promoting high-value health care.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: This study was supported by RI8HS18339 from the Agency for Healthcare Research and Quality (AHRQ) and the Mayo Clinic Foundation.

Disclosures: None.

Disclaimers: None.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Table S1: Effects of Age and Encounter Restrictions on Cohort Composition and Performance Measurement (Sensitivity Analysis).