Original Article

Development and Validation of Electronic Quality Measures to Assess Care for Patients With Transient Ischemic Attack and Minor Ischemic Stroke

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Background—Despite interest in using electronic health record (EHR) data to assess quality of care, the accuracy of such data is largely unknown. We sought to develop and validate transient ischemic attack and minor ischemic stroke electronic quality measures (eQMs) using EHR data.

Methods and Results—A random sample of patients with transient ischemic attack or minor ischemic stroke, cared for in Veterans Health Administration facilities (fiscal year 2011), was identified. We constructed 31 eQMs based on existing quality measures. Chart review was the criterion standard for validating the eQMs. To evaluate eQMs in terms of eligibility, we calculated the proportion of patients who were genuinely not eligible to receive a process (based on chart review) and who were correctly identified as not eligible by the EHR data (specificity). To assess eQMs about classification of whether patients received a process, we calculated the proportion of patients who actually received the process (based on chart review) and who were classified correctly by the EHR data as passing (sensitivity). Seven hundred sixty-three patients were included. About eligibility, specificity varied from 25% (brain imaging; carotid imaging) to 99% (anticoagulation quality). About pass rates, sensitivity varied from 30% (antihypertensive class) to 100% (coronary risk assessment; international normalized ratio measured). The 16 eQMs with ≥70% specificity in eligibility and ≥70% sensitivity in pass rates included coronary risk assessment, international normalized ratio measured, HbA1c measurement, speech language pathology consultation, anticoagulation for atrial fibrillation, discharge on statin, lipid management, neurology consultation, Holter, deep vein thrombosis prophylaxis, oral hypoglycemic intensification, cholesterol medication intensification, antihypertensive intensification, antihypertensive class, carotid stenosis intervention, and substance abuse referral for alcohol.

Conclusions—It is feasible to construct valid eQMs for processes of transient ischemic attack and minor ischemic stroke care. Healthcare systems with EHRs should consider using electronic data to evaluate care for their patients with transient ischemic attack and to complement and expand quality measurement programs currently focused on patients with stroke. **(*Circ Cardiovasc Qual Outcomes*. 2017;10:e003157. DOI: 10.1161/CIRCOUTCOMES.116.003157.)**

Key Words: electronic health records ■ ischemic attack, transient ■ sensitivity and specificity ■ stroke

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WHAT IS KNOWN

- Despite interest in using electronic health record instead of manual chart review to assess condition-specific quality of care both for processes of care and for outcomes, the accuracy of using such data for the assessment of stroke and transient ischemic attack care are largely unknown.
- Previous studies have, in general, been less explicit about issues related to eligibility for a process and have focused primarily on agreement in whether the measure was passed.

WHAT THE STUDY ADDS

- To our knowledge, this is the first study to assess the feasibility of measuring quality of care for patients with transient ischemic attack or minor stroke using existing electronic health record data.
- A key methodological advance to the existing electronic quality measurement literature is the detailed examination of how electronic quality measures compared with the criterion chart review separately for issues related to eligibility for a given process and the pass rate for that process.
- This study examined a large set of performance measures that included a broad array of clinical processes of care for patients with transient ischemic attack and minor stroke and demonstrated that it is feasible to construct valid electronic quality measures for key processes of acute transient ischemic attack and minor stroke care.

There has been a call for using electronic health record (EHR) data instead of manual chart review to assess condition-specific quality of care for both processes of care and outcomes.[1–6] The Centers for Medicare and Medicaid Services (CMS) has proposed widespread adoption of electronic quality measures (eQMs) based on EHR data.[7] The articulated challenge for the next generation of clinical performance measures is to assess quality of care for an entire population longitudinally as opposed to conducting chart reviews on a sample of patients at single points in time.[4]

See Editorial by Adelman and Burke

The American Heart Association/American Stroke Association (AHA/ASA) has proposed a set of process measures for use in evaluating quality of care for patients with acute ischemic stroke and transient ischemic attack (TIA).[8] Similar measures have been supported by the Joint Commission (JC) and the National Quality Forum.[9,10] The JC stroke measures are part of the CMS Hospital Inpatient Quality Reporting Program.[7] Yet, the evaluation of stroke care quality focused on processes of care has historically relied on chart review. Although some investigators have examined the challenges in constructing certain ischemic stroke quality measures from EHR data,[11] this study has not included all harmonized stroke quality measures or the processes of care that have been associated with improved outcomes for patients with TIA.[12–14]

The Veterans Health Administration (VHA) currently tracks 3 self-reported hospital-based measures of ischemic stroke care quality and previously implemented measurement of the JC stroke metrics based on chart review data.[15] The VHA does not currently assess quality of care for patients with TIA. Although patients with TIA and minor ischemic stroke are at high risk of recurrent vascular events, evidence demonstrates that timely delivery of guideline concordant care dramatically reduces this risk.[16–20] By measuring care quality for all patients with TIA and minor ischemic stroke, providers can help ensure that patients receive the care they need to prevent recurrent vascular events.

We sought to develop and validate eQMs that could be assessed for patients with TIA and minor ischemic stroke using readily available EHR data and that could be used for the evaluation of care at the facility level. Specifically, we were interested in evaluating guideline-concordant care processes that could serve as targets for future quality improvement efforts.

Methods

Terminology: EHR Versus Chart Review Data

The VHA has a robust electronic medical record system which is known as the Computerized Patient Record System and which is based on the VistA (Veterans Health Information Systems and Technology Architecture) platform. Many data elements (eg, vital signs, laboratory information, and medication information) are available within existing VHA data sources that are not generally available in administrative data for other health systems. In this project, EHR data refer to data elements that are routinely available for patients in the VHA through existing VHA data sources, whereas chart review data refer to information that is collected by human abstracters reading medical records. Information that is stored in text fields (either free text or templated text) are not routinely available in existing VHA EHR databases and thus were not included in the development of these TIA or minor ischemic stroke eQMs.

Rationale for Focus on TIA and Minor Ischemic Stroke

The rationale for including both patients with TIA and those with minor ischemic stroke in this project was based on 4 elements: approximately one third of patients with transient neurological symptoms who would have been classified according to the traditional time-based definition of TIA have evidence of infarct on brain imaging and would therefore be classified as having a minor ischemic stroke according to the tissue-based definition of TIA[21]; numerous studies have examined prognosis after TIA and minor ischemic stroke and found that both groups are at high and similar risk of recurrent vascular events[20,22,23]; several intervention studies have included patients with both TIA and minor ischemic stroke[17,24]; and the AHA/ASA prevention guidelines provide similar recommendations for patients with TIA and minor ischemic stroke.[25]

Overall Design

We used *International Classification of Diseases-Ninth Revision* (*ICD*-9)-CM codes to identify patients with TIA or minor ischemic stroke who were cared for in any VHA Emergency Department (ED) or inpatient setting during fiscal year (FY) 2011 (see Cohort Construction section of this article). We then identified a random sample of patients from the 45 facilities with the highest patient volume

and selected a 35% random sample with a minimum of 25 patients per site. We focused on high-volume facilities so that we could evaluate the use of the eQMs at the facility level. Patients were excluded if chart review did not confirm a TIA or ischemic stroke diagnosis, if the time from symptom onset to presentation was >30 days, or if they did not have a mild stroke (defined as an National Institute of Health Stroke Scale [NIHSS] score of[26] <3). The chart review data served as the criterion standard for validity testing of the eQMs.

Cohort Construction

Our goal was to identify all patients with TIA or minor ischemic stroke who were cared for in either the ED or inpatient setting. The cohort was constructed in 5 steps. First, we identified Veterans with TIA or ischemic stroke (minor or major) who were cared for in any VHA ED or inpatient setting during FY 2011 (October 2010 to September 2011) using the ICD-9 codes of 435.X, 433.X1, 434.00, 434.X1, and 436.[27] We used the diagnosis codes for the inpatient period for patients who were admitted and used ED diagnosis codes for patients cared for only in the ED. The earliest event date in FY 2011 was used as the index event.

Second, we classified patients with ischemic stroke as either major or minor. Because the EHR data for patients in FY 2011 did not include the NIHSS or other measure of stroke severity (in contrast to the medical records from which a retrospective NIHSS could be obtained), an approach to identifying patients with minor ischemic stroke was developed.[28] Briefly, the algorithm for the differentiation of patients with minor versus major ischemic stroke was developed using data from the VHA Office of Quality and Performance (OQP) Stroke Special Project, which included detailed chart review on 3965 patients with ischemic stroke who were hospitalized in any VHA medical center in FY 2007.[27] Nurse abstractors trained in the collection of the retrospective NIHSS conducted the chart reviews and documented the NIHSS on the basis of the admission neurological examination.[26] Minor stroke (defined as an NIHSS ≤2) was present in 1925 (48.5%) and major stroke was present in 2040 (51.5%) patients in this chart review cohort. EHR data were linked with the chart review data. Our study team iteratively developed 17 EHR data algorithms on the basis of a priori clinical judgment to identify patients with minor stroke. We calculated the sensitivity and specificity for each algorithm. The algorithm with the best performance had a sensitivity of 47.4%, specificity of 78.3%, and correctly classified ≈60% of patients as having a minor versus a major stroke. According to this algorithm, patients discharged with a diagnosis of stroke were classified as having major stroke if any of the following were present: the length of stay was ≥6 days, ventilator use, feeding tube use, coma, intensive care unit stay, received inpatient rehabilitation services, or receipt of thrombolysis on the day of presentation. Major stroke patients were excluded.

Third, we used the EHR data (based on the algorithm described above) to identify patients with TIA and minor stroke for chart review. Medical records were screened for 1624 patients, 822 were considered eligible for full chart abstraction (defined as a patient with a probable TIA or stroke, where the symptom onset was within 30 days of presentation and where the stroke was minor [NIHSS ≤2]). Among the 802 patients who were not eligible for full abstraction the reasons for exclusion (not mutually exclusive) included NIHSS >2 (n=429), not considered as a TIA or stroke by the admitting clinical team (n=336), other (n=30) (eg, acute care performed at non-VHA facility and being referred to the VHA facility for rehabilitation care only or for carotid stenosis procedure; recent completed evaluation of cerebrovascular symptoms in patient with likely alternative diagnosis for current symptoms such as dehydration or infection; or alternative explanation for neurological symptoms such as Dilantin toxicity, neuropathy, Bell's palsy, or metastatic cancer), and symptom onset earlier than 30 days before presentation (n=16).

Fourth, on the basis of the chart review information, we refined the EHR algorithm. We excluded the following: patients with an ICD-9 code 435.2 (subclavian steal syndrome) because none were found to have either a TIA or minor ischemic stroke index event; patients who only had a consultation by an emergency medicine provider but who were not actually cared for in the emergency department setting; non-Veteran patients (eg, family members or staff who had a TIA or minor stroke but who did not get their regular care from the VHA facility), patients cared for in an ED with a code for TIA or stroke but who were admitted within 1 day for a noncerebrovascular diagnosis (because on chart review nearly all of these patients actually had a noncerebrovascular problem and not a TIA or minor stroke), and patients where the death date was before the presentation date.

Finally, we identified a random sample of patients (n=763) from the 45 facilities with the highest patient volume and selected a 35% random sample with a minimum of 25 patients per site. These patients then received a full chart review and were included in this study.

Chart Review: Interobserver Reliability

To assess inter-rater reliability, our goal was to conduct double abstraction on a 10% random sample of records. Because we did not have an a priori sense of the proportion of charts that would be ineligible for inclusion in the chart review, we began by identifying 20% of records for double abstraction and then decreased that proportion after the first year of abstraction. Agreement between chart reviewers for categorical variables was measured by percent agreement and by the κ statistic, which is agreement adjusted for random chance; κ's were interpreted using Landis and Koch benchmarks.[29] The κ is influenced by prevalence, with reductions in κ observed when the prevalence is either very low or very high.[30] The latter situation is relevant to the current study given that we anticipated high pass rates for certain processes of care (eg, we expected that almost all patients would receive brain imaging); for this reason, we used both agreement and κ to quantify interobserver reliability. The strength of interobserver reliability in continuous variables was measured by the intraclass correlation coefficient (ICC), which describes the proportion of total variation in observations that is because of subject-to-subject variability in the true value. Higher levels of random error associated with the measurement process result in lower ICC values; 1–ICC is the proportion of total variation from different measurements of the same subject (ie, variation arising from different chart reviewers). An ICC of 1.0 indicates that there was no difference within a subject between chart reviewers.

eQM Development

Process measures were identified from several different sources including: AHA/ASA stroke guideline recommended elements of care for patients with TIA or ischemic stroke,[25] the 2014 Evidence-Based Guideline for the Management of High Blood Pressure in Adults,[31] measures currently being used in VHA quality assessment (eg, for primary care quality assessment), measures included in the JC Stroke Core Measure Set,[15] or measures that were part of the proposed AHA/ASA quality metrics.[8,32] EQMs were developed for 31 processes of care which spanned 15 domains of care (Table 1): (1) brain imaging; (2) carotid artery imaging and timely carotid stenosis intervention; (3) cardiac monitoring with electrocardiography, telemetry, or Holter; (4) hypertension control, antihypertensive medication class, and antihypertensive medication intensification; (5) anticoagulation for atrial fibrillation or atrial flutter, international normalized ratio (INR) measured, and anticoagulation quality (INR between 2 and 3); (6) lipid measurement, prescription of lipid-lowering agents or statins at discharge, prescription of moderate or high potency statin at discharge, and lipid-lowering medication intensification; (7) diabetes mellitus management with HbA1c measurement and oral hypoglycemic medication intensification; (8) antithrombotics by day 2 and discharge; (9) deep vein thrombosis prophylaxis (with or without exclusion of patients who were ambulatory); (10) neurology consultation; (11) rehabilitation consultation; (12) speech language pathology consultation; (13) nicotine replacement therapy for smokers; (14) substance abuse treatment referral for alcohol abuse; and (15) coronary risk assessment. Appendix I in the Data Supplement includes definitions for each process of care. Process-measure algorithms were developed for use with VHA administrative data and were iteratively refined on the basis of comparisons with the chart

Table 1. Electronic Quality Measures

Clinical Domain		Alternatives to AHA/ASA Measures	Secondary Measures
	Core AHA/ASA Measures for Stroke and TIA*		
Antithrombotics	Antithrombotics at discharge		
	Antithrombotics by hospital day 2		
Atrial fibrillation	Anticoagulation for atrial fibrillation/flutter	INR measured	Anticoagulation quality
Hyperlipidemia	Statin at discharge	Lipid management	Lipid measurement
			Cholesterol-lowering intensification
Smoking		Nicotine replacement therapy for smokers†	
Carotid stenosis	Carotid artery imaging		Carotid stenosis management
Hypertension			Hypertension medication intensification
			Hypertension control
			Antihypertensive medication class
	Core AHA/ASA Measures for Stroke*		
DVT prophylaxis	DVT prophylaxis		DVT prophylaxis (ambulatory excluded)
Rehabilitation	Rehabilitation needs assessment		
Dysphagia	Dysphagia screening	Speech language pathology consultation	
	Dysphagia management		
Cardiac monitoring		Electrocardiography	
		Telemetry	
		Holter monitor	
Diabetes mellitus			HBA1c measurement
			Hypoglycemic medication intensification (oral medications)
			Hypoglycemic medication intensification (insulin)
Brain imaging			Brain imaging
Alcohol abuse			Substance abuse treatment referral for alcohol use
Neurology			Neurology consultation
Coronary risk			Coronary risk assessment

AHA/ASA indicates American Heart Association/American Stroke Association; DVT, deep vein thrombosis; INR, international normalized ratio; and TIA, transient ischemic attack.

*The AHA/ASA performance measure set for hospitalized patient with ischemic stroke included thrombolytic therapy, time to intravenous thrombolysis, stroke education, and National Institute of Health Stroke Scale assessment, which were not included in the current study because they are either less relevant for the TIA/minor ischemic stroke population or could not be reliably converted into an electronic quality measure.

†The AHA/ASA performance measure set includes tobacco use counseling which could not be reliably abstracted from electronic health record data; therefore we developed the alternative measure related to the prescription of nicotine replacement therapy for tobacco smokers.

review data (Appendix II in the Data Supplement provides an example algorithm for the carotid imaging process).

eQM Data Sources

A variety of data sources were used to construct the eQMs. VHA Austin inpatient and outpatient data files in the 5 years pre-event (FY 2005–2012) were used to identify past medical history,[33] healthcare utilization (eg, hospitalizations, office visits), and receipt of procedures (eg, brain imaging using Current Procedural Terminology, Healthcare Common Procedures Coding System, and ICD-9 procedure codes). Pharmacy Benefits Management data were used to identify medications. Corporate Data Warehouse data were used for vital signs (eg, blood pressure), laboratory data (eg, lipids, HbA1c), allergies, orders, and consults. Linked VA-CMS data were used to identify comorbidity and hospitalizations in non-VHA facilities. VA Fee-Basis Data were used to identify inpatient and outpatient utilization and medical history. The date of death was obtained from the VA Vital Status File. (Appendix II in the Data Supplement provides an example of the specific diagnosis and procedure codes that were used in eQM development).

eQM Validation

We assessed the validity of the eQMs by comparing the eQMs constructed from EHR data to the same QMs constructed from chart review data (criterion standard). The validity of the eQMs was tested first for eligibility (the denominators of the eQM) and then separately for the pass rate (the numerators of the eQM). The Figure displays the 2-by-2 tables that were used to conceptualize the validation analysis.

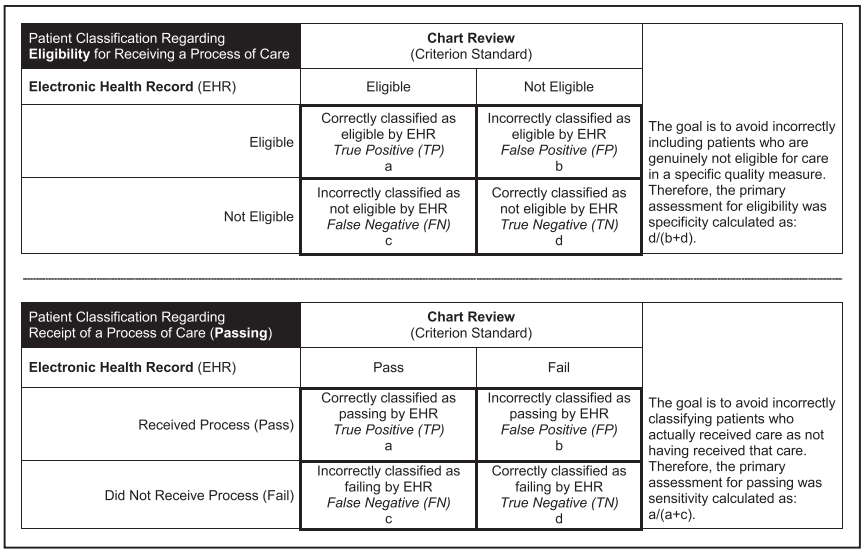

Figure. Conceptualization of validity assessment. EHR indicates electronic health record; FP, false-positives; FN, false-negatives; TP, true-positives; and TN, true-negatives.

Eligibility Validation

Implementation of quality measures in practice requires both the inclusion of all eligible patients and the exclusion of patients who are not eligible. However, to be acceptable to clinicians who are subject to quality assessment, inclusion of patients who are not actually eligible for a given process must be avoided as clinicians are likely to reject measures wholesale if patients who were not eligible for a process, and who therefore appropriately did not receive a process are classified as a fail when they should have been classified as not eligible. Therefore, for the assessment of how well the EHR data performed in terms of classifying eligibility for each process of care, we calculated the proportion of patients who were genuinely not eligible to receive a process (based on chart review information) and who were correctly identified as being not eligible on the basis of the EHR data (specificity; Figure).

Passing Validation

Implementation of quality metrics in practice requires avoiding the situation where a quality measure classifies a patient as a fail when the clinician actually provided care and therefore the patient should really be classified as a pass. Therefore, for the assessment of how well the EHR data performed in terms of classifying whether a patient received a process of care, we calculated the proportion of patients who actually received the process (on the basis of the chart review) and who were classified correctly by the EHR as passing the measure (sensitivity; Figure). We conducted this assessment among the patients who were identified as being eligible for a process in both the EHR cohort and chart review cohort.

In addition to sensitivity and specificity, positive and negative predictive values were also calculated. Accuracy was calculated as the sum of the true-positives (TP) and true-negatives (TN) over the sum of TP, false-positives [FP], TN, and false-negatives [FN]).[34] Finally, Matthew correlation coefficient (MCC) was calculated for each eQM according to the formula: MCC=[(TP*TN)–(FP*FN)]/[((TP+FP)*(TP+FN)*(TN+FP)*(TN+FN))$^{0.5}$].[35] The MCC describes agreement between 2 classification systems: in this case, between the electronic data and the chart review data. An MCC of 1 indicates perfect agreement, 0 indicates a random guess, and −1 indicates perfect disagreement. If an eQM had high sensitivity and high specificity, then the MCC would approach 1. If an eQM had high specificity and low sensitivity or high sensitivity and low specificity, then the MCC would be intermediate.

Facility-level pass rates were calculated as the number of patients who passed a measure divided by all of the patients treated at that facility who were eligible for a measure. Facility pass rates for each process of care were examined for facilities with at least 10 eligible patients (where eligibility was determined on the basis of chart review).

This project received human subjects approvals from the Institutional Review Board and VHA Research and Development Committees.

Results

Cohort Construction and Validation

A total of 763 patients were included in the cohort. The patient volume varied across the n=45 facilities from 54 patients to 218 patients with a mean volume of 98 patients.

All patients were considered as having a possible TIA or minor ischemic stroke at the time of presentation and therefore clinically eligible to receive care for patients with presumed TIA or minor ischemic stroke. Based on chart review data, they were classified as having a final diagnosis of: TIA (n=502; 65.8%), minor ischemic stroke (n=253; 33.2%), or as neither TIA nor minor ischemic stroke (n=8; 1.1%). There was agreement between the EHR data and the chart review in terms of overall diagnostic classification as either TIA or minor ischemic stroke versus not TIA or minor ischemic stroke in 755 of 763 cases (99.0%; Table 2).

The characteristics of the cohort are provided in Table 3. Although the EHR data identified more comorbid conditions than the chart review, the Charlson comorbidity score was 1 point higher in the chart review cohort. The chart review data provided information about the clinical uncertainty inherent in making a TIA diagnosis, especially differences in the initial diagnosis (made in the ED or on admission) versus the final diagnosis (made at the end of the index presentation; Table 3).

Table 2. Diagnostic Agreement Between Chart Review and Electronic Health Record Data (n=763)

Electronic Health Record Data	Chart Review Data			Total
	Minor Ischemic Stroke	TIA	Not TIA or Stroke	
Minor ischemic stroke	234	66	4	304 (39.8%)
TIA	19	436	4	459 (60.2%)
Total	253 (33.2%)	502 (65.8%)	8 (1.0%)	763 (100%)
	755 (99.0%)		8 (1.0%)	

TIA indicates transient ischemic attack.

Table 3. Comparison of Baseline Characteristics Between Electronic Health Record and Chart Review Data

Characteristic	Electronic Health Record Data		Chart Review Data		*P* Value
	n=763	%	n=763	%	
Demographics					
Age, y, range, median	30–94, 66		30–94, 65		…
Mean±SD	68.1±11.3		67.6±11.3		0.3876
Race					
White	566	74.2	514	67.4	0.0034
Black	153	20.1	152	19.9	…
Hispanic	17	2.2	32	4.2	…
Asian	2	0.3	8	1.1	…
Native American	3	0.4	3	0.4	…
Other/unknown	22	2.9	54	7.1	…
Married	381	49.9	379	49.7	0.9184
Male sex	718	94.1	716	93.8	0.8297
Past medical history					
Prior stroke	197	25.8	185	24.3	0.4783
Prior TIA	168	22.0	123	16.1	0.0034
History of amaurosis fugax	17	2.2	14	1.8	0.5862
Prior carotid endarterectomy or stent	61	8.0	39	5.1	0.0229
Diabetes mellitus	311	40.8	290	38.0	0.2712
Hypertension	624	81.8	628	82.3	0.7896
Hyperlipidemia	556	72.9	518	67.9	0.0331
Myocardial infarction	116	15.2	89	11.7	0.0427
Coronary artery disease/ischemic heart disease/CABG/PCI/coronary stent	247	32.4	249	32.6	0.9130
Pacemaker or AICD	19	2.5	60	7.9	<0.0001
Peripheral vascular disease	198	26.0	65	8.5	<0.0001
Atrial fibrillation	87	11.4	85	11.1	0.8714
Congestive heart failure	183	24.0	77	10.1	<0.0001
Valvular heart disease: native or mechanical	105	13.8	25	3.3	<0.0001
COPD/asthma	278	36.4	129	16.9	<0.0001
Sleep apnea	128	16.8	91	11.9	0.0069
Seizure disorder	52	6.8	27	3.5	0.0039
Migraine disorder	44	5.8	44	5.8	1.0000
Dialysis dependent	19	2.5	10	1.3	0.0915
Dementia	35	4.6	62	8.1	0.0046
Depression	270	35.4	191	25.0	<0.0001
Charlson comorbidity score, range, median	0–12, 1		0–13, 2		…
Mean±SD	1.6±1.9		2.6±2.0		0.0001
Index event					
Final diagnosis					
TIA	459	60.2	502	65.8	0.0226
Minor ischemic stroke	304	39.8	253	33.2	…
Not stroke or TIA	…	…	8	1.1	…
Symptoms at time of presentation	…	…	375	49.1	…
ABCD^2 score, range, median	…	…	0–7, 4		…
Mean±SD	…	…	4.0±1.5		…
NIHSS score,* range, median	…	…	0–18, 0		…
Mean±SD	…	…	1.0±1.5		…

ABCD^2 refers to a measure of recurrent vascular event rate risk; AICD, automatic implantable cardioverter-defibrillator; CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; NIHSS, National Institute of Health Stroke Scale; PCI, percutaneous coronary intervention; and TIA, transient ischemic attack.

*The NIHSS was recorded for patients with either TIA or minor ischemic stroke and was based on the first physical examination documented upon presentation. If a patient with stroke had an NIHSS of >2, they were excluded from the chart review. However, patients with TIA were not excluded on the basis of the NIHSS.

Chart Review: Interobserver Reliability

Double abstraction was performed on a 17% (n=131) random sample of medical records. Among the 136 categorical variables involved in the process-measure definitions, the agreement between chart reviewers was 100% for 41% (n=56) of variables, 90% to 99% for 46% (n=62) of variables, 80% to 89% for 12% (n=17) of variables, and <80% for 1% (n=1) of variables. κ's were calculated with 75% of variables having substantial (33%; $0.60<\kappa\leq0.80$) or perfect (42%; $0.80<\kappa$) agreement. Another 12% had moderate ($0.40<\kappa<0.60$) agreement, 9% had fair or slight ($0.20<\kappa\leq0.40$) agreement, and 4% had poor agreement. Among the 28 continuous variables involved in the process-measure definitions, the ICC was 1.00 for 61%, 0.90 to 0.99 for 21%, 0.80 to 0.89 for 7%, and <0.80 for 11%.

eQM Validation: Eligibility Assessment

For the 31 eQMs, the comparison of the EHR data and the criterion chart review data for eligibility for each process is provided in Table 4. The eQMs are ranked by specificity (*). The eQMs with specificity <70% are identified by the label ELT70 (Table 4). The specificity of the eligibility for the eQMs varied from a low of 25.0% for brain imaging and carotid imaging to a high of 98.6% for anticoagulation quality.

eQM Validation: Pass Rate Assessment

Table 5 provides the comparison of the EHR data and the criterion chart review data for the pass rates for the 31 eQMs that are ranked by sensitivity (*). Table 5 indicates which eQMs had a specificity <70% for eligibility (from Table 4) by the label ELT70; eQMs with <70% sensitivity for the

Table 4. Comparison of Chart Review vs the Administrative Data for Eligibility for Processes of Care (n=763)

Processes	Eligible by EHR		Not Eligible by EHR		Sensitivity (a/[a+c]), %	Specificity (d/[b+d]), %*	95% CI,* %	PPV, %	NPV, %	MCC, %	ACC, %
Eligible by Chart Review (Criterion Standard)	Yes (a)	No (b)	Yes (c)	No (d)							
Anticoagulation quality	32	10	9	712	78.05	98.61	97.76–99.46	76.19	98.75	0.7580	0.9751
Oral hypoglycemic medication intensification	47	11	11	694	81.03	98.44	97.53–99.35	81.03	98.44	0.7947	0.9712
Carotid stenosis intervention	14	13	1	735	93.33	98.26	97.32–99.20	51.85	99.86	0.6883	0.9817
INR measured	32	14	9	708	78.05	98.06	97.05–99.07	69.57	98.74	0.7210	0.9699
Substance abuse referral for alcohol	26	36	22	679	54.17	94.97	93.37–96.57	41.94	96.86	0.4366	0.924
Speech language pathology consultation	567	10	11	175	98.10	94.59	91.33–97.85	98.27	94.09	0.9252	0.9725
Anticoagulation for atrial fibrillation/flutter	53	40	12	658	81.54	94.27	92.55–95.99	56.99	98.21	0.6469	0.9318
Antihypertensive class among hypertensives at discharge	164	34	104	461	61.19	93.13	90.90–95.36	82.83	81.59	0.5916	0.8191
DVT prophylaxis	419	22	26	296	94.16	93.08	90.29–95.87	95.01	91.93	0.8709	0.9371
HBA1c measurement	283	33	14	433	95.29	92.92	90.59–95.25	89.56	96.87	0.8731	0.9384
Coronary risk assessment	157	42	106	458	59.70	91.60	89.17–94.03	78.89	81.21	0.5552	0.806
Antihypertensive intensification	220	66	22	455	90.91	87.33	84.47–90.19	76.92	95.39	0.7522	0.8847
Antihypertensive class among hypertensives ≤90 d	137	72	131	423	51.12	85.45	83.34–88.56	65.55	76.35	0.3915	0.7339
Telemetry	463	52	15	233	96.86	81.75	77.27–86.23	89.90	93.95	0.8119	0.9122
Nicotine replacement therapy	133	109	35	486	79.17	81.68	78.57–84.79	54.96	93.28	0.5418	0.8113
Cholesterol medication intensification	408	49	123	183	76.84	78.88	73.63–84.13	89.28	59.80	0.5229	0.7746
Lipid management	513	50	49	151	91.28	75.12	69.14–81.10	91.12	75.50	0.6651	0.8702
Discharged on statin	513	50	49	151	91.28	75.12	69.14–81.10	91.12	75.50	0.6651	0.8702
Holter	642	27	17	77	97.42	74.04	65.61–82.47	95.96	81.91	0.746	0.9423
Neurology consultation	757	0	6	0	99.21	…	…	100.00	0.00	…	0.9921
ELT70 Hypertension control (n=608)†	575	9	4	20	99.31	68.97	52.13–85.81	98.46	83.33	0.7473	0.9786
ELT70 High or moderate potency statin at discharge	636	43	15	69	97.70	61.61	52.60–70.62	93.67	82.14	0.6705	0.924
ELT70 DVT prophylaxis (ambulatory excluded)	76	317	14	356	84.44	52.90	49.13–56.67	19.34	96.22	0.2410	0.5662
ELT70 Antithrombotics at discharge	670	47	11	35	98.38	42.68	31.97–53.39	93.44	76.09	0.5344	0.9240
ELT70 Rehabilitation consultation	708	30	4	21	99.44	41.18	27.67–54.69	95.93	84.00	0.5698	0.9554
ELT70 Antithrombotics by day 2	671	50	9	33	98.68	39.76	29.23–50.29	93.07	78.57	0.5247	0.9227
ELT70 Lipid measurement	712	30	2	19	99.72	38.78	25.14–52.42	95.96	90.48	0.5768	0.9581
ELT70 Antihypertensive medication class at discharge	570	109	15	69	97.44	38.76	31.60–45.92	83.95	82.14	0.4891	0.8375
ELT70 Electrocardiography	666	69	4	24	99.40	25.81	16.92–34.70	90.61	85.71	0.4387	0.9043
ELT70 Carotid artery imaging	685	57	2	19	99.71	25.00	15.26–34.74	92.32	90.48	0.4523	0.9227
ELT70 Brain imaging	663	72	4	24	99.40	25.00	16.34–33.66	90.20	85.71	0.4304	0.9004

ACC indicates accuracy (the sum of the true-positives and true-negatives over the sum of true-positives, false-positives, true-negatives, and false-negatives); DVT, deep vein thrombosis; EHR, electronic health record; ELT70, processes of care with a specificity of <70% for eligibility; INR, international normalized ratio; MCC, Matthew correlation coefficient; NPV, negative predictive value; and PPV, positive predictive value.

*The electronic quality measures are ranked by specificity.

†There were 608 patients with valid blood pressure measurements; for all other processes n=763.

Table 5. Comparison of Chart Review vs the Administrative Data for Pass Rates for Processes of Care (n=763)

Process	Passing by EHR		Failing by EHR								
Passing on Basis of Chart Review (Criterion Standard)	Yes (a)	No (b)	Yes (c)	No (d)	Sensitivity (a/[a+c]),* %	95% CI,* %	Specificity (d/[b+d]), %	PPV, %	NPV, %	MCC	ACC
Coronary risk assessment	1	5	0	151	100.00	…	96.79	16.67	100.00	0.4017	0.9682
INR measured	32	0	0	0	100.00	…	…	100.00	…	…	1.0000
HBA1c measurement	219	14	2	48	99.10	97.85–100.35	77.42	93.99	96.00	0.8298	0.9435
Speech language pathology consultation	123	41	2	401	98.40	96.20–100.60	90.72	75.00	99.50	0.8149	0.9242
ELT70 Lipid measurement	575	48	11	78	98.12	97.02–99.22	61.90	92.30	87.64	0.6927	0.9171
Anticoagulation for atrial fibrillation/flutter	41	5	1	6	97.62	93.01–102.23	54.55	89.13	85.71	0.6248	0.8868
Discharged on statin	420	34	15	44	96.55	94.83–98.27	56.41	92.51	74.58	0.5961	0.9045
Lipid management	427	31	16	39	96.39	94.65–98.13	55.71	93.23	70.91	0.5781	0.9084
ELT70 Hypertension control† (n=608)	378	39	15	143	96.18	94.28–98.08	78.57	90.65	90.51	0.7789	0.9061
ELT70 Brain imaging	629	7	25	2	96.18	94.71–97.65	22.22	98.90	7.41	0.1077	0.9517
ELT70 Antithrombotics by day 2	590	32	27	22	95.62	94.01–97.23	40.74	94.86	44.90	0.3802	0.9121
ELT70 Antithrombotics at discharge	581	39	34	16	94.47	92.66–96.28	29.09	93.71	32.00	0.2461	0.8910
ELT70 Carotid artery imaging	426	50	28	181	93.83	91.62–96.04	78.35	89.50	86.60	0.7412	0.8861
Neurology consultation	529	68	41	119	92.81	90.69–94.93	63.64	88.61	74.38	0.5962	0.856
ELT70 High or moderate potency statin at discharge	123	114	10	389	92.48	88.00–96.96	77.34	51.90	97.49	0.5872	0.805
Holter	15	19	2	606	88.24	72.93–103.55	96.96	44.12	99.67	0.6108	0.9673
DVT prophylaxis	309	27	44	39	87.54	84.09–90.99	59.09	91.96	46.99	0.4262	0.8305
Oral hypoglycemic medication intensification	13	6	2	26	86.67	72.63–104.71	81.25	68.42	92.86	0.6451	0.8298
Cholesterol medication intensification	95	25	15	273	86.36	79.95–92.77	91.61	79.17	94.79	0.7594	0.902
Antihypertensive intensification	43	20	7	150	86.00	76.38–95.62	88.24	68.25	95.54	0.6882	0.8773
ELT70 Rehabilitation consultation	289	45	48	326	85.76	82.03–89.49	87.87	86.53	87.17	0.7366	0.8686
ELT70 DVT prophylaxis (ambulatory excluded)	56	2	10	8	84.85	76.20–93.50	80.00	96.55	44.44	0.5156	0.8421
ELT70 Antihypertensive medication class at discharge	314	32	84	140	78.89	74.88–82.90	81.40	90.75	62.50	0.5666	0.7965
ELT70 Electrocardiography	433	38	140	55	75.57	72.05–79.09	59.14	91.93	28.21	0.2644	0.7327
Antihypertensive class among hypertensives at discharge	88	4	29	43	75.21	67.39–83.03	91.49	95.65	59.72	0.6078	0.7988
Carotid stenosis intervention	3	0	1	10	75.00	32.56–117.44	100.00	100.00	90.91	0.8257	0.9286
Substance abuse referral for alcohol	0	1	0	25	…	…	96.15	0.00	100.00	…	0.9615
PLT70 Telemetry	267	14	157	65	62.97	58.37–67.57	82.28	95.02	29.28	0.3316	0.66
PLT70 Nicotine replacement therapy	54	10	39	30	58.06	48.03–68.09	75.00	84.38	43.48	0.3035	0.6316
PLT70 Anticoagulation quality	4	1	3	24	57.14	20.48–93.80	96.00	80.00	88.89	0.6051	0.8750
PLT70 Antihypertensive class among hypertensives ≤90 d	22	14	52	49	29.73	19.32–40.14	77.78	61.11	48.51	0.085	0.5182

ACC indicates accuracy (the sum of the true-positives and true-negatives over the sum of true-positives, false-positives, true-negatives, and false-negatives); DVT, deep vein thrombosis; EHR, electronic health record; ELT70, processes of care with a specificity of <70% for eligibility (from Table 4); INR, international normalized ratio; MCC, Matthew correlation coefficient; NPV, negative predictive value; PLT70, processes of care with a sensitivity of <70% for passing; and PPV, positive predictive value.

*The electronic quality measures are ranked by sensitivity.

†There were 608 patients with valid blood pressure measurements; for all other processes, n=763.

pass rate are identified by the label PLT70. The sensitivity of the pass rates varied from a low of 29.7% for the antihypertensive class among patients with hypertension within 90 days of the index event to a high of 100.0% for coronary risk assessment and for INR measured among patients with anticoagulation.

The MCCs in Table 5 were generally higher for processes with high sensitivity in terms of the pass rate, but there were

2 notable exceptions to that rule: brain imaging and carotid stenosis intervention. The brain imaging process had a relatively higher sensitivity of 96.2%, but the MCC was only 0.11 reflected the lower specificity of 22.2%. For 25 patients, the chart review indicated that the patients received brain imaging but the EHR data had no evidence of brain imaging (FN), and for 7 patients, brain imaging information was found in the EHR but not in the chart review (FP). The majority of FN were for patients where brain imaging had been performed at a community (non-VHA) hospital and where the results were documented in the medical record but for whom no VHA brain image was performed and therefore no brain imaging code was found in the EHR data. In contrast, the carotid stenosis intervention had a lower sensitivity of 75.0%, but the MCC was 0.83 and the specificity was 100.0%. These results reflected the very small sample size for this measure.

Overall eQM Validation

There were 16 eQMs with ≥70% specificity in eligibility and ≥70% sensitivity in pass rates including coronary risk assessment, INR measured, HbA1c measurement, speech language pathology consultation, anticoagulation for atrial fibrillation, discharge on statin, lipid management, neurology consultation, Holter, deep vein thrombosis prophylaxis, oral hypoglycemic intensification, cholesterol medication intensification, antihypertensive medication intensification, antihypertensive class among hypertensive patients at discharge, carotid stenosis intervention, and substance abuse referral for alcohol. Conversely, the 15 eQMs with <70% specificity for eligibility or sensitivity for the pass rate included lipid measurement, hypertension control, brain imaging, antithrombotics by day 2 or at discharge, carotid artery imaging, high or moderate potency statin at discharge, rehabilitation consultation, deep vein thrombosis prophylaxis excluding ambulatory patients, antihypertensive medication class at discharge, electrocardiography, telemetry, nicotine replacement therapy, anticoagulation quality, and antihypertensive class among hypertensive patients within 90 days.

Facility-Level Pass Rates

The mean pass rates at the facility level (for facilities with at least 10 eligible patients) varied across the eQMs from a low of 3.6% for Holter use to high of 94.8% for INR measured among patients on anticoagulation (Table 6). Variation in performance across sites was demonstrated by higher values for the interquartile range; for example, the median facility pass rate for neurology consultation for facilities with at least 10 eligible patients was 82.4% and interquartile range of 20.9% (Table 6).

Discussion

This study assessed the feasibility of measuring quality of care for patients with TIA or minor ischemic stroke using existing EHR data. A key methodological advance to the existing electronic quality measurement literature is the detailed examination of how eQMs compare with the criterion chart review separately for issues related to eligibility for a given process and the pass rate for that process. Prior studies have, in general, been less explicit about issues related to eligibility for a process and have focused primarily on agreement in whether the measure was passed.[12,13]

Dr Linda Williams' group conducted a key-related study in this field, developing 5 eQMs for patients with ischemic stroke: deep vein thrombosis prophylaxis, antithrombotics by hospital day 2 and at discharge, rehabilitation assessment, and documentation of the NIHSS.[11] Similar to the approach used in the current study, they compared results of queries based on the EHR with chart review for patients from 11 VHA hospitals. The current project differs from this previous study gives our focus on TIA (rather than stroke), the inclusion of all acute care VHA facilities (rather than 11 hospitals participating in a quality improvement project), and the evaluation of a broad array of processes of care. The current project is similar to this previous study in the main finding that individual processes of care vary in terms of agreement with the EHR. The 2 studies had very similar findings for antithrombotics both at hospital day 2 and discharge with high denominator sensitivities but with low specificities.[11]

Because no accepted standard exists for the evaluation of eQMs, organizations that seek to implement eQMs will be faced with competing priorities on the choice of which eQMs to use. At a minimum, the choice involves 3 key domains: the clinical importance of a process of care, the availability of existing electronic data, and the performance characteristics of the eQM compared with a criterion or gold standard (in this case, chart review).

For this study, we examined 31 eQMs across 15 domains of care. We cannot rank the clinical importance of those domains given the heterogeneity in the evidence that links diagnostic and therapeutic processes with outcomes for patients with cerebrovascular disease.[25] For example, we cannot answer the question: Which is more important, anticoagulation for atrial fibrillation or carotid artery imaging? Organizations that seek to implement eQMs need to consider the relative importance of a given process when evaluating the eQM validity data. Very reasonably, these organizations may opt to include eQMs on the basis of the clinical importance of the process rather than its performance characteristics when compared with chart review. For example, carotid stenosis management is a Class I; Level of Evidence A from the AHA/ASA secondary prevention guidelines; therefore, carotid imaging is a key process of TIA care.[25] The eQM for carotid imaging had relatively high sensitivity for pass rate (94%) but low sensitivity for eligibility (25%). Organizations seeking to implement this clinically important eQM should carefully examine denominator exclusions: for example, although excluding patients who leave against medical advice (AMA) is clinically reasonable, the lack of AMA discharge data from the ED setting caused irreconcilable differences between the chart review data and the EHR data in our cohort. A final consideration related to clinical importance of an eQM involves the sample size of the eligible patient population at the facility level.

About data quality, EHR systems are likely to have unique challenges relevant to both eligibility and pass rates. In general, processes with eligibility criteria that were based on items that are routinely found in administrative databases (eg, diagnosis codes, procedure codes, or discharge disposition) had strong performance (eg, carotid stenosis intervention).

Table 6. Performance of Electronic Quality Measures at the Facility Level*

	Overall Performance		Performance at Sites With ≥10 Eligible Patients								
	Facilities With Any Eligible Patients*	Mean Facility Pass Rate	Facilities	No. of Patients per Facility			Mean Pass Rate	Min	Max	Median	IQR
Process of Care	n	%†	n	Min	Max	Median	%	%	%	%	%
INR measured	59	94.8	…	…	…	…	…	…	…	…	…
ELT70 Brain imaging	39	93.1	34	11	43	21	93.4	75	100	95	8.7
ELT70 Antithrombotics at discharge	39	92.8	34	11	43	21	92.0	76.2	100	92.7	12.5
ELT70 Antithrombotics by day 2	39	91.7	34	11	43	21	90.8	75.0	100	91.5	13.0
Lipid management	39	89.2	31	12	43	21	88.1	58.3	100	88.9	13.7
ELT70 Lipid measurement	39	88.5	34	11	43	21	87.9	66.7	100	89.7	11.2
Discharged on statin	39	88.4	31	12	43	21	87.1	58.3	100	88.2	15.2
HBA1c measurement	39	81.3	14	18	43	24.5	80.3	58.3	100	78.5	15
ELT70 DVT prophylaxis (ambulatory excluded)	39	79.1	21	15	43	21	78.9	40	100	88.9	25.6
DVT	39	78.8	24	13	43	21	79.1	40	100	87.3	24.1
Anticoagulation for atrial fibrillation	39	77.6	1	36	36	36	90	90	90	90	0
ELT70 Hypertension control	59	73.9	33	10	46	19	71.9	55	100	70	11.9
Neurology consultation	39	73.6	34	11	43	21	79	38.9	100	82.4	20.9
ELT70 Electrocardiography	39	69.6	34	11	43	21	68.4	13	100	75.4	37.8
ELT70 Carotid artery imaging	39	67.5	34	11	43	21	67.3	34.8	91.7	67.5	17.4
ELT70 Antihypertensive medication class at discharge	39	58.9	32	12	43	21	59.2	33.3	88.2	58.7	14.6
Antihypertensive class among hypertensives at discharge	39	58.3	5	26	43	36	58	36.4	81.8	50	38.3
PLT70 Telemetry	39	53.9	30	13	43	21	54.8	0	100	64.4	54.9
ELT70 Rehabilitation consultation	39	49.0	34	11	43	21	45.7	5.6	71.4	46.9	22.4
Oral hypoglycemic intensification	59	44.8	…	…	…	…	…	…	…	…	…
PLT70 Nicotine replacement therapy	39	43.1	7	16	43	27	41.6	6.3	75	45.5	54
Antihypertensive intensification	39	36.2	10	16	43	24.5	31.3	0	80	28.2	27.3
ELT70 High or moderate potency statin at discharge	39	34.1	33	12	43	21	35.2	9.5	76.5	31.3	20.4
Cholesterol medication intensification	39	28.6	25	13	43	22	28.7	0	58.3	30.8	18.9
Speech language pathology consultation	39	28.1	32	12	43	21	29.8	0	86.7	27	31
PLT70 Antihypertensive class among hypertensives within 90 d	59	22.3	2	27	41	34	26.8	23.5	30	26.8	6.5
Carotid stenosis intervention	39	13.0	…	…	…	…	…	…	…	…	…
PLT70 Anticoagulation quality	59	8.0	…	…	…	…	…	…	…	…	…
Substance abuse referral for alcohol	39	7.6	…	…	…	…	…	…	…	…	…
Coronary risk assessment	59	6.6	4	29	41	35	6.6	0	18.2	4.2	13.3
Holter	59	3.6	33	12	41	20	6.1	0	26.7	5.6	7.7

DVT indicates deep vein thrombosis; ELT70, processes of care with a specificity of <70% for eligibility; INR, international normalized ratio; and PLT70, processes of care with a sensitivity of <70% for passing.

*Chart review was conducted at 45 facilities. There were n=59 facilities for some measures because for the postdischarge measures, quality of care was attributed to the facility that provided primary care to the patient, which may or may not have been the same facility that provided care for the index event.

†The electronic quality measures are ranked according to the mean facility pass rate.

Similarly, processes with pass rates based on procedures or laboratory tests had strong performance (eg, HbA1c measurement). In some cases, we found the results of laboratory tests in the EHR data that were not present in the chart review (eg, FP for HbA1c, lipid measurement). As described by other authors, it may be that the electronic data are more accurate than chart review in these situations.[12] Generally, for processes that relied on orders (eg, telemetry), if we identified the order in the EHR, then it was nearly always also present in the chart review data. In contrast, processes with tight time constraints

for eligibility had lower performance (eg, lipid measurement with exclusions within 2 days of index event presentation).

For some processes, differences between the EHR data and the chart review data are unlikely to be easily rectified, whereas with other processes, disagreement may indicate gaps in EHR data that could be addressed with modifications to current systems. For example, for some processes (eg, anticoagulation for atrial fibrillation), patient refusal can be a source of disagreement between the EHR and the medical record; in such a case, it may be possible to create elements in the EHR to identify patient preferences.[5]

We determined in advance that the key consideration when evaluating eligibility would be the proportion of patients who were genuinely not eligible to receive a process and who were correctly identified as being not eligible on the basis of the EHR data (specificity) because implementation of quality metrics in practice requires avoiding the inclusion of patients who are not eligible for a given process. We also determined in advance that the proportion of patients who actually received the process and who were classified correctly by the EHR as passing the measure (sensitivity) would be the key consideration when evaluating passing validity because implementation of quality metrics in practice requires minimizing the classification of patients as fails when they actually received a process. The data provided in Tables 4 and 5 demonstrate that other choices could be made to rank eQMs (eg, MCC or accuracy) that would produce a different set of measures identified as best or even acceptable. These tables illustrate how agreement alone is inadequate as a measure of eQM performance, and we recommend that future studies of eQMs report results using a variety of test characteristics.

The 16 eQMs with ≥70% specificity in eligibility and ≥70% sensitivity in pass rates encompassed different domains of care: medication therapy (eg, anticoagulation for atrial fibrillation), laboratory testing (eg, HbA1c measurement), consultation (eg, speech language pathology), diagnostic procedures (eg, Holter monitoring), and therapeutic procedures (eg, carotid stenosis intervention). They also spanned the continuum of care from the early postevent period (eg, neurology consultation) to discharge (eg, discharge on statin) to the postdischarge period (eg, INR measured). The evidence from 1 VHA-based study that quality of care in one part of the care continuum (eg, processes provided in the ED) was unrelated to care in other parts of the continuum (eg, processes provided at discharge or by primary care) within a given facility underscores the need to develop quality metrics that describe key components of care across the entire continuum of care.[36]

Several national organizations have called for the measurement of processes of care for patients with acute stroke and TIA.[8,10,15,37] The increased interest in using electronic data instead of chart review for the measurement of quality stems from a general emphasis on Meaningful Use, the emergence of commercial EHR systems, the need to reduce the considerable costs involved in detailed chart review, and the implementation of the CMS electronic Clinical Quality Measures program.[3,4] The CMS electronic Clinical Quality Measures validation pilot identified a variety of challenges for eQM implementation including the need for hospital EHR systems to include needed data as searchable data elements (rather than free text) and standardization of key data elements.[7] A few studies have evaluated the validity of using EHR data for the assessment of quality and have found that EHR data perform well in comparison with chart review, but none of these have focused on processes of care within TIA populations.[12,13,38]

There has been considerable interest in measuring quality of care for patients with stroke both within and outside of the VHA.[7,9,28] There seem to be fewer organizations; however, actively monitoring quality of care for patients with TIA[39] despite the evidence that providing timely, guideline-concordant care substantially reduces the risk of recurrent vascular events.[16–19] National organizations such as the AHA/ASA, JC, NQF, and CMS may wish to consider implementing quality measurement programs that focus specifically on patients with TIA. One consideration related to the implementation of TIA performance measurement is the diagnostic uncertainty inherent in the TIA diagnosis and the related issues of validity with TIA coding. In the current study, the primary discrepancy between EHR data and chart review was related to the identification of patients with minor (versus major) stroke. The NIHSS >2 exclusion was present in 429 of 1624 patients (26.4%) in the EHR sample. The next most common reason for exclusion was that the patient was not considered as a stroke or TIA by the admitting team that was present in 336 of 1624 patients (20.7%) who were included in the EHR sample. The question of how inclusion of such patients in a quality reporting system might influence the feasibility or usefulness differs for these 2 exclusions. In the case of potentially including patients with major stroke in a measurement system that is targeting TIA and minor stroke, it is likely that the application of the eQMs to patients with major stroke would not compromise acceptance of the measurement system because patients with major stroke are generally eligible for all of the processes that are recommended for patients with TIA and minor stroke. In contrast, including patients who are not considered to have a stroke or TIA as the primary presenting clinical problem would be problematic for clinical acceptance. Healthcare systems must assess the relative value of conducting quality measurement among a high-risk group of patients with the existing limitations in coding.

For most quality assessment programs, patients are identified on the basis of discharge diagnosis. This approach has strong face validity and is mostly likely to include eligible patients. However, for conditions where there is both some diagnostic uncertainty early and a need for timeliness in care, it may be appropriate to consider applying the quality measurement to the presenting complaint. In the case of TIA, certain processes of care are relevant to making a correct diagnosis (eg, brain imaging).[21]

Future research in this field should address issues related to implementation of performance measurement for patients with TIA and minor stroke. Specifically, future research should evaluate clinicians perspectives on the benefits versus harms of measurement in a clinical domain where the relatively high risk of adverse events can be substantially reduced by timely interventions but the condition has an inherent diagnostic uncertainty that makes identification of patients difficult. It may be that clinicians would welcome timely and actionable data about their patients—which would be feasible

using eQMs in healthcare systems with EHRs—as long as the eQMs are used for clinical care or local quality improvement and not for high-stakes report cards or profiling.

Strengths and Limitations

The strengths of this research include its examination of a large set of performance measures that included a broad array of clinical domains and its rigor in validating via chart review. For example, the validation of the brain imaging and carotid artery imaging processes may have value for the assessment of quality for patients with major ischemic stroke. An additional strength of the study is its focus on VHA data and VHA facilities, as the VHA comprises the largest integrated healthcare system in the United States. The VHA began implementing electronic quality measurement—mostly in primary care—in FY 2015.

The focus on the VHA, however, may also represent a study limitation in that eQMs feasible for construction within the robust VHA EHR system may be less feasible or valid within healthcare systems where administrative (claims) data do not include pharmacy, laboratory, and consultation data and where Medicare data may not be routinely available. Increasingly, however, the results may be generalizable to healthcare systems using certified commercial EHR systems that do include vital sign, pharmacy, laboratory, and orders data.

The algorithms that were validated in this study were based on ICD-9 codes and translation to ICD-10 will be required for implementation in the current routine practice.

Although a strength of the current project is the inclusion of a variety of processes of care, some of those processes may be more relevant to patients with stroke than patients with TIA. For example, patients with transient neurological symptoms are unlikely to require rehabilitation assessment. A limitation of EHR data are that it cannot be used to identify patients with versus those without residual neurological symptoms. Future studies should evaluate the degree to which eQMs for TIA and minor stroke are associated with postevent patient outcomes.

After the approach used by the JC, we evaluated (Table 5) and reported (Table 6) the proportion of eligible patients who receive processes of care,[9] rather than constructing risk-adjusted models.

We assessed the performance of the eQMs in the entire population; future studies should evaluate the degree to which validity in eligibility and pass rate varies across facilities.

Finally, we conceptualized this project as a comparison of eQMs against a criterion standard of chart review. We made this choice because the existing standard approach for quality measurement by the JC and other national organizations that monitor quality of care is based on chart review.[9,39,40] The consequence of this conceptualization is that if an eQM disagreed with chart review, we considered it to have poor validity. However, for some data fields (eg, laboratory tests), it may be that the electronic data were more accurate than the chart review data[12,13]; if so, then we may have underestimated the true validity of the eQMs.

Conclusions

These results demonstrate that it is feasible to construct valid eQMs for key processes of acute TIA and minor ischemic stroke care. Healthcare systems with EHRs should consider routinely using electronic data to evaluate care for their patients with TIA and to complement and expand quality measurement programs currently focused on patients with stroke. The eQMs that were validated in this project are being deployed as part of a quality improvement project in the VHA system.

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Disclosures

None.

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