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Modelling care quality for patients after a transient ischaemic attack within the US Veterans Health Administration

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ABSTRACT

Objective Timely preventive care can substantially reduce risk of recurrent vascular events or death after a transient ischaemic attack (TIA). Our objective was to understand patient and facility factors influencing preventive care quality for patients with TIA in the US Veterans Health Administration (VHA).

Methods We analysed administrative data from a retrospective cohort of 3052 patients with TIA cared for in the emergency department (ED) or inpatient setting in 110 VHA facilities from October 2010 to September 2011. A composite quality indicator (QI score) pass rate was constructed from four process-related quality measures—carotid imaging, brain imaging, high or moderate potency statin and antithrombotic medication, associated with the ED visit or inpatient admission after the TIA. We tested a multilevel structural equation model where facility and patient characteristics, inpatient admission, and neurological consultation were predictors of the resident's composite QI score.

Results Presenting with a speech deficit and higher Charlson Comorbidity Index (CCI) were positively related to inpatient admission. Being admitted increased the likelihood of neurology consultation, whereas history of dementia, weekend arrival and a higher CCI score made neurological consultation less likely. Speech deficit, higher CCI, inpatient admission and neurological consultation had direct positive effects on the composite quality score. Patients in facilities with fewer full-time equivalent neurology staff were less likely to be admitted or to have a neurology consultation. Facilities having greater organisational complexity and with a VHA stroke centre designation were more likely to provide a neurology consultation.

Conclusions Better TIA preventive care could be achieved through increased inpatient admissions, or through enhanced neurology and other care resources in the ED and during follow-up care.

INTRODUCTION

Patients with transient ischaemic attack (TIA) are at high risk of recurrent vascular events, including repeat TIA, stroke and death.[1–6] Timely delivery of guideline-concordant cerebrovascular preventive care can reduce risk of these events. Therefore, patients with TIA are ideal candidates for risk reduction interventions.[7–10] Timeliness of interventions is an important consideration because preventive actions will achieve maximum benefit if received soon after an index cerebrovascular event.[11] Guideline-consistent care for TIA has improved substantially over the last few years; nonetheless, considerable variation remains in care quality between patients and among facilities.[12 13] Paradoxically, patients with TIA at highest risk for a recurrent cardiovascular event may be least likely to receive guideline-consistent care.[14]

Our study objective was to understand patient and facility factors influencing quality of care provided to patients with TIA treated within the Veterans Health Administration (VHA) System. Quality indicators (QIs), selected from prior research and clinical guidelines, covered diagnostic evaluations including receipt of carotid imaging and brain imaging, as well as treatment interventions including prescription of high or moderate potency statins and antithrombotics.[7 15 16] These four QIs were incorporated into a composite measure of care quality. To meet these objectives, we develop and test a multilevel, structural equation model (SEM) for the relationships between patient and facility characteristics and the composite QI measure. Our sample includes patients with TIA either discharged from the emergency department (ED) or admitted to the hospital.

METHODS

We used VHA electronic health record data to select a sample of 3052 patients with a TIA. The sample represented all admissions to the ED or hospital meeting study criteria who were cared for in the ED or inpatient setting in 110 VHA facilities for the 12-month period from October 2010 to September 2011. Patients with an *International Classification of Diseases, Ninth Revision* code of 435.x primary discharge code were classified as having a TIA. The diagnosis for this study cohort was found to be accurate when validated

Table 1 Operational definitions of quality measures

Quality measure	Numerator	Denominator	Exclusions
Brain imaging	Patients receiving brain imaging (Brain CT or MRI) within 2 days of index event	TIA patient cohort	Died within 2 days of index event Discharged to hospice within 2 days of index event Left AMA within 2 days of index event; Transferred to another non-VA acute care facility within 2 days of index event Admitted from a non-VA acute care facility
Carotid artery imaging	Patients receiving a carotid imaging procedure within 2 days after index event or 6 months before the index event	TIA patient cohort	Died within 2 days of index event Transferred to another non-VA acute care facility within 2 days of index event Discharged to hospice Patients who left against medical advice within 2 days of index event
High or moderate potency statin	Patients who receive statin therapy within 7 days after discharge (with >1 day of supply) defined as follows: ≤75 years of age: high potency statin >75 years of age: moderate or high potency statin	TIA patient cohort	Transferred to another non-VA acute care facility Patients who died during the hospital stay or during ED visit Patients who left against medical advice Patients discharged to hospice Patients with allergy to statin therapy
Antithrombotics	Percent of patients with TIA or minor stroke who receive antithrombotic therapy within 7 days after discharge (with an outpatient supply >1 day)	TIA patient cohort	Died during hospital stay Discharged to hospice Transferred to another non-VA acute care facility Patients who left against medical advice Patients with an allergy to antithrombotic medication Patients who receive tPA within 2 days of discharge

AMA, against medical advice; ED, emergency department; TIA, transient ischaemic attack; tPA, tissue plasminogen activator; VA, Veterans Affairs.

with chart reviews.[17] For patients who were cared for in the ED only, we selected the primary discharge diagnosis for their ED visit; for patients who were admitted, we selected the primary hospital discharge diagnosis. Patients admitted for observation were coded as an inpatient admission. A total of 3697 patients from 132 VHA facilities were identified as TIA admissions to the ED or hospital during the year. We excluded 22 facilities with fewer than 10 admissions (n=88 excluded patients) of patients with TIA because small numbers could result in unreliable facility estimates. Excluded facilities had higher rates of TIA inpatient admission, and were less likely to be located in an urban area or to have stroke centre designation. Another 536 patients were excluded because they were ineligible for one or more QIs and, as a result, would not have complete composite scores. Thus, all patients included in these analyses were eligible to receive all four quality measures as described in table 1. Institutional review board and VHA Research and Development approvals were received to support this research.

The VHA inpatient and outpatient data were the primary data sources. They were supplemented by linked Medicare claim files for the 65% of Veterans in the sample who were Medicare eligible. The VHA files alone or in combination with Medicare files were used to identify past medical history, presenting symptoms and healthcare utilisation (eg, inpatient admission or ED only). Pharmacy Benefits Management data were used to identify medications during the ED visit or inpatient stay; Corporate Data Warehouse data were used to identify vital signs, laboratory data, medication allergies (eg, statin allergies), orders, and consultations.

The outcome variable was a patient-level composite score based on four inpatient QIs: carotid imaging within 2 days after index event or within 6 months before the index event, brain imaging within 2 days of index event, high or moderate potency statin prescribed within 7 days after discharge and antithrombotic (includes both antiplatelet or anticoagulation medications) prescribed within 7 days after discharge. The two medication-based processes were initially defined as receipt of the medication at the time of hospital discharge, but the definition was changed to within 7 days after discharge based on prior work validating the electronic quality measures versus chart review (eg, if a clinician ordered a medication on the day of discharge, it could take some time for that order to be filled by the pharmacy). Operational definitions of these measures are shown in table 1. Eligible patients were classified on each measure as pass (1) or fail (0). Although guidelines recommend a variety of processes of acute TIA care, these four QIs were chosen because of their clinical relevance (they each have a strong evidence base to support their use as performance measures)[7 15]; they can be provided across a full spectrum of medical facilities (they do not require specialised services); they include both diagnostic (eg, brain and carotid artery imaging) and therapeutic (eg, antithrombotics, statins) elements of care; the majority of patients with TIA are eligible to receive these processes of care (unlike anticoagulation for patients with atrial fibrillation which is only relevant to a minority of patients or cardiac monitoring which is similarly relevant in only a subgroup of patients with TIA); and they have been demonstrated to be valid for use in electronic quality measurement (compared against the gold standard of chart review).[16 17] The composite measure of TIA care quality was defined as the proportion of the four QIs that the patient passed (ie, 0%, 25%, 50%, 75%, 100%), which was treated as a continuous variable for purposes of estimating the SEM.

We examined the relationship between the composite care quality measure and selected patient and facility characteristics. Variables were chosen because they have been associated in prior studies with inpatient admission or care quality of stroke or patients with TIA. Patient characteristics included presenting symptoms of speech deficit, the Charlson Comorbidity Index (CCI),[18] history of dementia and arrival on a weekend (ie, any time on Saturday or Sunday). A timely neurologist consultation was defined as occurring within 1 day of the index event; it could occur in the ED or after the decision to admit. Symptoms of hemiplegia were also significantly related to admission at the bivariate level; however, we excluded them from the model because of high collinearity with speech deficit (results not shown). All patient-level variables were binary with the exception of the CCI.

At the Veterans Affairs Medical Centres (VAMCs) facility level, we included binary variables (scored 0/1) for falling in the bottom quartile for equivalent (full-time equivalent (FTE)) neurologists per 100 000 patients; stroke centre self-designation of comprehensive stroke centre or limited hours stroke centre versus other facilities that cannot offer consistent stroke care[19]; high VHA facility complexity level, defined by size, teaching service, and availability of intensive care services[20]; and high TIA patient volume defined as 25 or more patients with TIA per year.

We specified and tested a causal model of the effects of patient and facility characteristics, inpatient admission, and neurological consultation on a patient's QI score. Variable selection and causal structure of the model were determined a priori based on prior research (see discussion section) and available data. We hypothesised that patient characteristics (eg, having dementia, multiple other comorbidities and presenting with a speech deficit) and weekend arrival would influence whether the patient was admitted to the hospital and whether they would receive a neurological consultation, either in the ED or during the inpatient stay. We expected VAMCs with greater availability of neurologists and other stroke care resources (eg, stroke centre designation and greater organisational complexity) would have higher rates of admission and neurological consultation. Correspondingly, we expected that patients admitted to the hospital and receiving neurological consultations would also receive higher quality care.

We tested these hypotheses with a multilevel path model with a combination of categorical and continuous observed variables using MPlus software.[21] Figure 1 shows the structure of the model with arrows indicating significant causal paths from the final model. History of dementia, CCI, symptoms of a speech deficit and arrival on the weekend were treated as exogenous variables, which means that they were assumed to have no causal influence on each other, although they could be correlated. We specified causal paths from patient characteristics to inpatient admission and neurological consultation, and a causal path from inpatient admission to neurological consultation. The facility variables, FTE neurologists, stroke centre designation, organisational complexity and TIA volume were also assumed to be exogenous. We specified causal paths from facility variables to inpatient admission and neurological consultation. After testing for the effects of different FTE neurologist quartiles, we settled on a dummy variable of the bottom quartile (compared with quartiles 2–4) as most predictive of admission and neurological consultation.

For the statistical modelling, we chose the MPlus Two-Level option with the robust MLR estimator for non-normal data, clustering on VAMC and the EMA optimisation algorithm.[21] Fit statistics for the model were based on the difference in log likelihood between the null and full nested models with a scaling correction factor.[21]

Patient and public involvement

Patients, clinicians and policymakers are deeply interested in quality of care and the benefits to be derived from this study. Because this was a retrospective study of data from an administrative record, it was not feasible to involve patients in study design or dissemination of findings to individual patients.

RESULTS

Among the 3052 patients in the cohort, 95% were men and 45% were younger than age ≤65, 44% age 66–85 and 11% >age 85 (table 2). Relatively, small percentages had a history of dementia (7%) or presented with speech deficits (13%). The mean CCI was 1.77 (SD: 2.10). Eighteen percent of patients arrived on the weekend. Two-thirds of patients were admitted and the remainder discharged directly from the ED. Sixty-three percent of patients had a neurology consultation. Most of the VAMCs were located in urban areas; 69% were classified as complex; 62% had a designation as a comprehensive or limited hours stroke

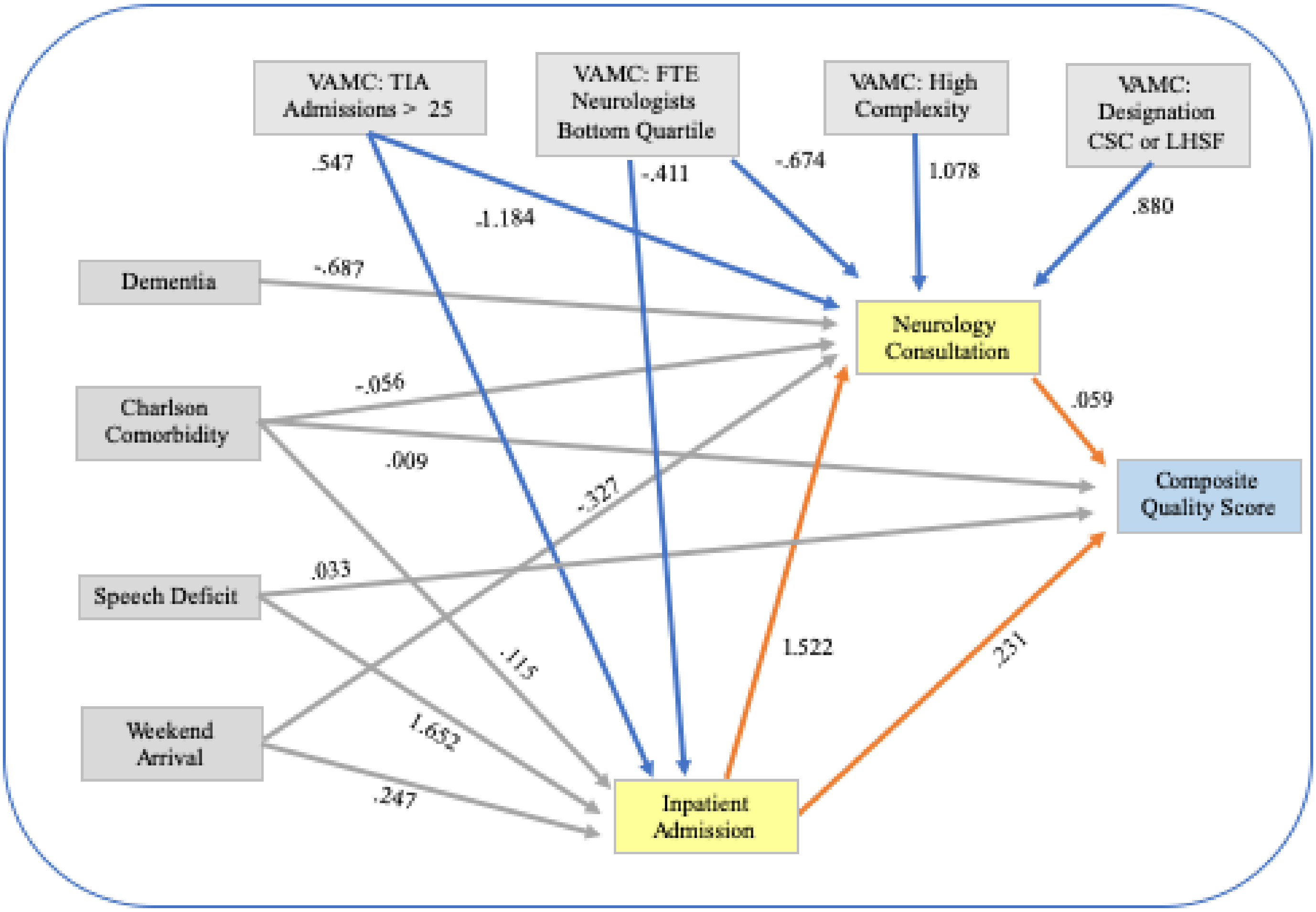

Figure 1 Path model with patient and facility characteristics, inpatient admission, neurological consultation and composite care quality. Regression (path) coefficients for the structural equation model. Arrows indicate statistically significant (p<0.05) paths with regression coefficients. Standard errors and p values are reported in the table. Exogenous patient variables are dementia, Charlson Comorbidity Index, speech deficit and weekend arrival; exogenous facility-level variables are VMAC facility complexity measure, full-time equivalent neurology staff (bottom two quartiles),>25 TIA patients per year, and designation as a comprehensive stroke centre or limited hours stroke facility; and endogenous patient variables are inpatient admission and neurology consultation. TIA, transient ischaemic attack; VMCA, Veterans Affairs Medical Centre.

centre[19]; and 35% had 25 or more patients with TIA per year. The average FTE neurologists per 100 000 patients ranged from 3.06 for the bottom quartile (0.00–5.62) to 17.44 (11.86–26.85) for the top quartile. Only four facilities had no FTE neurologists.

Pass rates on the individual QIs were as follows: 36% for carotid imaging, 86% for brain imaging, 57% for high or moderate potency statin at discharge and 90% for antithrombotic at discharge. The composite QI pass rates ranged from 0.00 to 1.00. Only 1% of patients had a score of 0.00 (no QIs passed); 11% a score of 0.25; 26% a score of 0.50; 42% a score of 0.75 and 21% a score of 1.00. The mean patient-level composite score was 0.67 with a SD of 0.236.

The 110 VAMCs had a mean composite facility-level QI score of 0.67. There was considerable variation in their scores with the bottom quintile of facilities ranging from 0.45 to 0.61 and top quintile ranging from 0.74 to 0.85. The interclass correlation was 0.09, indicating that 9% of the variance in scores was between facilities and 91% was among patients within facilities. The facility mean neurological consultation rate was 0.61 (SD=0.27; IQR=0.43–0.84) and the mean admission rate was 0.67 (SD=15; IQR=0.60–0.77)

Figure 1 shows the path model graphically with statistically significant (p<0.05) regression coefficients. Table 3 presents the regression coefficients, standard errors and level of statistical significance for each variable. A coefficient above 0.00 indicates a positive effect and below 0.00 a negative effect. The ratio of the regression coefficient to the SE in table 3 gives an indication of the strength of relationships. Two patient-level variables had significant positive effects on being admitted to the hospital: speech deficit (1.652) and CCI score (0.115). Weekend arrival (0.247) nearly achieved significance at p<0.059.

At the facility level, being in the bottom quartile for FTE neurologists had a negative effect on inpatient admission (−0.411), while having a higher volume of patients with TIA had a positive effect (0.547). Four patient-level variables had significant effects on neurological consultation:

Table 2 Patient and facility characteristics

Variable	%/Mean (number)	SD
Patient (n=3052)		
Male	95% (2905)	
Age ≤65	45% (1383)	
Age 66–85	44% (1344)	
Age>85	11% (325)	
Dementia Dx	7% (219)	
Mean Charlson Comorbidity Index (range=0–17)	1.77	2.10
Speech deficit	13% (405)	
Weekend arrival	18% (450)	
Inpatient admission	68% (2072)	
Neurologist consultation	63% (1908)	
Mean quality score (range=0.00–1.00)	0.67	0.24
Facility (n=110) organizational complexity	69% (81)	
Urban location	85% (105)	
25 or more patients with TIA	35% (39)	
Stroke centre designation*	62% (64)	
Mean FTE neurologists/100K patients	9.17	5.79
Bottom quartile	3.06 (27)	1.92
Second quartile	6.82 (28)	0.69
Third quartile	9.54 (28)	1.16
Fourth quartile	17.44 (27)	4.47

*Primary Stroke Centre or Limited Hours Stroke Facility
FTE, full-time equivalent; TIA, transient ischaemic attack.

admission to the hospital had a strong positive effect (1.522), whereas weekend arrival (−0.327), history of dementia (−0.687) and CCI (−0.056) had negative effects. Three facility-level variables had significant effects on receiving a neurological consultation: bottom quartile FTE neurologists had a negative effect (−0.674); stroke centre designation (0.880) and facility complexity (1.078) had positive effects.

Two patient characteristics had significant positive effects on QI score: speech deficit (0.033) and CCI (0.009). Inpatient admission had a strong positive effect (0.231) while neurological consultation had a modest effect (0.059) on QI score. In the initial models, we tested for significant effects between facility variables and care quality but found none; hence, facility-level variables did not directly influence the QI score after controlling for patient characteristics, neurological consultation and decision to admit. The log likelihood difference test (−4490, p <.001) indicated a good model fit.

To summarise, symptoms of a speech deficit and a higher CCI contributed to being admitted to the inpatient setting. Being admitted had a strong positive effect on receiving a neurology consultation. In contrast, weekend arrival, history of dementia and higher CCI score made neurological consultation less likely. Facilities with a greater volume of patients with TIA had higher inpatient admission rates, whereas facilities with greater complexity and facilities with a stroke centre designation had higher rates of neurological consultation. Inpatient admission had the strongest positive effect on care quality. A speech deficit and higher CCI score, and receiving a neurological consultation also had significant positive effects on care quality.

DISCUSSION

Prior studies of TIA care quality have dealt primarily with patients with TIA who were admitted to the hospital[13 14]; although one study by Kapral and colleagues[22] examined care quality for patients with TIA who were either admitted to the hospital or discharged directly from the ED. In their sample of patients from the Ontario Stroke registry, admitted patients were significantly more likely to receive recommended evaluations and treatments, including carotid and brain imaging, lipid-lowering medications and antithrombotic therapy.[22] They also found wide variation across hospitals in the proportion of patients with TIA admitted. Other studies have found that history of dementia,[23 24] multiple comorbidities,[25] speech deficit[26] and weekend arrival[27] have been associated with admissions or improved care quality for stroke or related chronic conditions.

We expand on prior research by including both patients with TIA who were discharged from the ED as well as those who were admitted to the hospital. We found that diagnosis and treatment of patients with TIA in the ED without admission to the hospital was a common occurrence (33% of patients), and one that had negative implications for care quality. We also expand on prior research by specifying and testing a causal model (SEM) that includes facility as well as patient characteristics. Prior studies have focused on patient-level characteristics, looking separately at patient characteristics as predictors of inpatient admission, or inpatient admission as a predictor of care quality. Our multilevel, SEM approach allowed us to specify and test specific causal relationships between both patient and facility-level variables simultaneously in a single set of equations.[28 29] The SEM approach provides more information than a conventional regression equation because it tests a pre-specified causal model. Moreover, we expanded on the typical single-level SEM model by examining effects at both facility and patient levels.

Admitting patients for evaluation and management of a suspected TIA is a complex decision, involving patient-level, provider-level and systems-level factors.[30] Hospitalisation of patients with TIA can lead to more rapid diagnostic evaluation, prompt initiation of appropriate cerebrovascular preventive therapies, and treatment of intracranial and carotid artery atherosclerosis.[31] On the other hand, outpatient evaluation and management of TIA can lower healthcare costs and potentially enhance patient convenience. Studies of post-TIA outpatient

Table 3 Significant patient and facility variables from the structural equation model

Independent and dependent variables	Regression coefficient	Standard error	Estimate/standard error	P value
Prediction of inpatient admission				
Weekend arrival	0.247	0.131	1.877	0.059
Charlson Comorbidity Index	0.115	0.021	5.473	<0.001
Speech deficit	1.652	0.171	9.641	<0.001
VAMC FTE neurologists (bottom quartile)	−0.411	0.151	−2.730	0.006
VAMC TIA patients>25/Year	0.547	0.142	3.857	<0.001
Prediction of neurological consultation				
Weekend arrival	−0.327	0.129	−2.529	0.011
Dementia	−0.687	0.165	−4.164	<0.001
Charlson Comorbidity Index	−0.056	0.024	−2.349	0.019
Inpatient admission	1.522	0.135	11.317	<0.001
VAMC FTE neurologists (bottom quartile)	−0.674	0.285	−2.363	0.018
VMAC stroke Centre: PSC or LHSF	0.880	0.300	2.931	0.003
VMAC facility complexity	1.078	0.333	3.236	0.001
Prediction of composite quality score				
Speech deficit	0.033	0.010	3.317	0.001
Charlson Comorbidity Index	0.009	0.002	4.190	<0.001
Inpatient admission	0.231	0.012	19.337	<0.001
Neurologist consultation	0.059	0.009	6.373	<0.001

FTE, full-time equivalent; LHSF, Limited Hours Stroke Facility; PSC, Primary Stroke Centre; TIA, transient ischaemic attack; VAMC, Veterans Affairs Medical Centre.

clinics—primarily from Europe—have shown that requisite evaluation can occur in less than a day for most patients, and only 25% of patients require being hospitalised for more than a day for appropriate therapies (eg, management of atrial fibrillation).[32] However, these specialised clinics are not routinely available in the VHA or other US health systems.

There are several possible explanations for the positive relationship between presenting with a speech impairment and both inpatient admission and care quality. An overt symptom, that is, speech impairment can reduce diagnostic uncertainty about the TIA, contributing to the decision to admit or initiate preventive care.[30] Among patients presenting to healthcare providers with TIA within another large, integrated healthcare system (Kaiser Health System), persistent neurological impairment in speech, strength and gait were positively associated with the decision to admit.[26] Speech is also a component of the $ABCD^2$ score, which in combination with other factors has been recommend for use in deciding on inpatient admission.[33]

The positive relationship between CCI and hospital admission was expected. Providers are more likely to admit 'medically complex' patients with TIA to the hospital, with a higher burden of medical comorbidities, and potentially downward healthcare trajectories. On the other hand, CCI had a negative effect on neurological consultation. For patients with comorbid conditions, management of concomitant active medical problems (eg, hypoxia secondary to aspiration pneumonia/pneumonitis; rapid atrial fibrillation) may have taken precedence over neurological consultation, and/or confirming the diagnosis of TIA was less important in this type of patient.

The positive effect of CCI on QI score is a welcomed finding. Among stroke patients, higher CCI scores have been associated higher rates of disability and mortality outcomes at hospital discharge and at 1-year follow-up.[25] Outside of the cerebrovascular population, patients with higher Charlson scores have been found to have higher rates of 30-day hospital readmission.[34]

It was interesting to discover that patients with a history of dementia were less likely to have a neurologist consultation, especially given that vascular risk factors are also well-established risk factors for the development and worsening of dementia.[35 36] Deficiencies in the quality of care for patients with dementia have been well documented.[23] We should point out that dementia had no significant relationship to the decision to admit or the QI score.

Although several facility-level characteristics have been associated with improved care for patients with stroke,[37–39] very little is known about facility factors that may affect care quality for patients with TIA. Our finding that weekend arrival lowered the likelihood of neurological consultation has been described in prior studies. On weekends, hospitals tend to have decreased staffing, and hence, decreased access to personnel to conduct testing (eg, carotid imaging) and evaluation (eg, neurology

Table 4 Implications of research findings for care quality and quality improvement initiatives

Key finding (direction of effect)	Implications for care quality and future quality improvement work
Care quality	
Speech deficit at presentation (+)	Presence of a speech deficit or other symptom may reduce diagnostic uncertainty. However, many patients with a TIA may have minimal, if any, overt symptoms by the time they seek care.
Higher CCI (+)	More medically complex patients may require inpatient admission for testing related to their presentation to differentiate symptoms that may be referential to an illness or to focal cerebrovascular ischemia (eg, hypoglycaemia among a patient with diabetes resulting in slurred speech). These patients may also present with concomitant worsening of a chronic medical illness or a new unrelated medical problem. Given that patients with CCI have poorer outcomes, earlier receipt of necessary TIA care may improve outcomes.
Inpatient admission (+)	Inpatient admission can increase the timeliness which patients receive guideline concordant evaluation (brain and carotid imaging) and management (receipt of high or moderate potency statin and antithrombotic medication) while enhancing access to Neurologist consultation. An alternative solution to inpatient admission includes increasing the availability of outpatient TIA assessment clinics.
Neurology consultation (+)	Neurologists may be more apt to provide evidence-based recommendations for patients with TIA. In the absence of on-site neurologists, innovative programmes to enhance access to specialty care include the use of telehealth and/or developing and implementing standardised, evidence-based protocols.
Receiving neurology consultation	
Inpatient admission (+)	Given decreased access to neurologists in the outpatient setting, ED providers may opt to admit patients with TIA to improve timely access to neurologist consultation.
Stroke centre designation (+)	These facilities have created systems to improve care delivery to patients with cerebrovascular events.
Facility complexity (+)	More complex facilities typically have greater availability of on-site specialty care providers.
Dementia (–)	May be secondary to the known association of dementia with lower care quality. Healthcare providers may embrace diagnostic and therapeutic nihilism when attending to patients with dementia and a TIA. The TIA may have been attributed to the dementia by the non-neurologist provider. While the presence of dementia did not negatively impact the quality indicator score, facilities should strive to provide access to needed post-TIA care regardless of cognitive function.
Higher CCI (–)	As these patients are more likely to have worsening of medical illness, these conditions may take priority over being evaluated by a neurologist. However, once a medical condition is attended to and a patient is more stable, appropriate post-TIA care should be delivered.
Weekend arrival (–)	Likely secondary to decreased availability of after-hours neurological consultation. Alternatives include developing protocols to improve access to neurologists with other VA medical centres (eg, via telehealth) or partnering with community hospitals which have greater availability of neurologists.
Fewer FTE Neurology staff (–)	If fewer neurologists are available within a medical centre, there is a decreased likelihood of patients with TIA seeing a neurologist.
Inpatient admission	
Speech deficit at presentation (+)	Speech deficit is a component of the $ABCD^2$ score, which is used to estimate risk of stroke after a suspected TIA and factors into consideration for admission, with higher $ABCD^2$ scores leading to higher rates of admission.
Higher CCI (+)	More medically complex patients may have multiple reasons for admission.
Fewer FTE Neurology staff (–)	If fewer neurologists are available within a given medical centre, ED and other providers may contend that there is less that they could offer patients with TIA or they may be less aware of TIA-care recommendations. Increased awareness and implementation of protocols to enhance delivery of best practices in TIA care should be considered.

Light blueshading indicates a positive association; light orange shading indicates a negative association.
CCI, Charlson Comorbidity Index; ED, emergency department; FTE, full-time equivalent; TIA, transient ischemic attack; VA, Veterans Affairs.

consultation).[40] A systematic review of studies examining off-hour (nights and weekends) admission of patients with acute ischaemic stroke found increased short-term mortality and disability for patients admitted during off-hours (ie, nights and weekends). The influence of off-hours admission among patients with TIA and stroke has been mitigated when facilities have a comprehensive stroke centre[40] where there is greater availability of personnel with stroke expertise.[41]

Our finding that composite care quality was most strongly affected by hospital admission is consistent with prior research.[22] Similarly, we expected a positive relationship between neurologist consultation and care quality. Neurologists often play a pivotal role in the inpatient management of patients with cerebrovascular disease within stroke centres and elsewhere.[30] The association between neurology consultation during the acute event, or afterwards in follow-up, and higher quality of care delivery has been demonstrated in the Early Use of Existing Preventive Strategies Stroke study.[42] Although this relationship between neurology consultation and both quality of stroke and TIA care[16 43 44] and improved patients outcomes[43 45–47] has been demonstrated in numerous studies, it remains unclear exactly what aspect of neurology consultation provides these benefits. In a note of caution about access to neurologists, Horner *et al*[48] found a selection effect; stroke patients admitted to a neurology service in their study had better prognostic profiles than a comparison group not admitted to the service. This finding is in line with our study where a higher Charlson morbidity had a negative effect on receiving a neurologist consultation. In addition, our facilities in the bottom quartile of FTE neurologists had low rates of impatient admissions. On the other hand, after taking into account morbidity and other patient characteristics in our SEM model, we found a direct positive effect of neurology consultation on care quality. Based on existing evidence, we would encourage systems caring for patients with TIA to ensure access to neurology consultation whether via traditional in-person or newer telehealth approaches.

These findings highlight the importance of the organisational context in influencing hospital admission and neurological consultation. As expected, patients in facilities with low FTE neurologists were less likely to receive a neurological consultation. Among other facility-level variables, greater TIA patient volume was positively associated with both hospital admission and receipt of neurology consultation, whereas greater organisational complexity and stroke centre designation were associated with patients with TIA seeing a neurologist. These findings suggest that more experience in caring for patients with TIA combined with greater expertise and care resources influence admission decisions and access to specialised care once admitted. Interestingly, none of the facility-level variables had significant direct effects on QI score, so their influence is likely mediated by their effect on admission and neurologist consultation.

We acknowledge several study limitations. The generalisability of findings is limited because the VHA is an integrated delivery healthcare system serving a Veteran population that is primarily male. Second, although the process measures were all validated against chart review, these data are drawn from administrative records.[17] Despite the extensive use of electronic records in the VHA, recording errors or omissions could affect the results. Third, we focused our analysis on care received either in the ED or inpatient setting after the TIA event. Future work should address longer-term outpatient TIA QIs such as those related to management of hypertension or post-discharge issues such as medication non-adherence.[28] Fourth, given that time of symptom onset is not available in the electronic data used in this study, we could not evaluate how differences in the time from symptom onset may influence the observed relationships. A patient who is distant from symptom onset and is no longer symptomatic is more likely to be discharged home from the ED in contrast to a patient who has more recent symptom onset who is still symptomatic. Finally, we acknowledge that the decision to admit a patient is complex and it can be influenced by many factors (eg, patient preference, bed availability) that were unmeasured in our study.[30]

CONCLUSIONS

Our findings raise a number of issues about delivery of high-quality care to patients after a TIA. First, there is the decision about inpatient admission. The Veterans Affairs (VA) and other healthcare organisations could strive to increase inpatient admissions for patients presenting with a TIA. Healthcare systems also might use observation units to expedite care for patients with TIA.[49 50] But, is the incremental increase in care quality associated with an inpatient admission worth the extra costs, both to the VA system and patients? Alternatively, resources might be directed to better coordinate follow-up care, particularly enhanced coordination between the ED, neurologists and primary care.[9 42] Rapid access outpatient clinics, for example, show promise as new models of TIA care, although they are yet to have a presence in the VA system. The VA has recently instituted a teleneurology programme to expand access in rural areas. It is too soon to tell how it will influence admitting practices or care quality. Presenting on the weekend diminished the chance of a neurologist consultation. The VA and other healthcare organisations should consider expanding on-call neurology staff and availability of other resources on the weekend and during off hours. Implications for our research findings on TIA care quality and possibilities for future quality improvement work are shown in table 4. Finally, providers should carefully consider how presenting symptoms and comorbid conditions may influence decisions about inpatient admissions, involvement of neurologists and adherence to guideline concordant preventive care.

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