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Urgent Neurology Consultation from the Emergency Department for Transient Ischemic Attack

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Keywords

Transient Ischemic Attack; Referral and Consultation; Emergency Medicine; Stroke

1. Introduction

Transient ischemic attack (TIA) is common with well over 300,000 Emergency Department (ED) visits for TIA in the United States each year.¹ The ED management for this common presentation is particularly challenging because TIA symptoms are by definition evanescent in nature, which makes them difficult for patients to describe, and because TIA symptoms can mimic diverse alternate diagnoses such as migraine or seizure, which makes the diagnosis more complex. Furthermore, the stakes for making an accurate diagnosis are high because there has been a growing appreciation that the early risk of stroke after TIA is high,² and that urgent evaluation and intervention may be effective at reducing this risk.^{3,4} Therefore, developing efficient and effective processes of care for ED patients with TIA has been a major goal for emergency medicine and stroke neurology.

Various models of care such as routine inpatient admission,⁵ Emergency Department observation units,⁶ or expedited outpatient follow-up clinics with stroke specialists^{3,4} have been proposed to help address this need but significant practice variation remains.⁷ Within this context, the potential role of urgent neurology consultation in the ED has received relatively less attention. Instead, previous studies have focused on the impact of consultation for ED patients generally¹⁰, or a neurologist's role within a stroke center or stroke network specifically,¹¹ or on the outcomes of inpatients with stroke who are under the care of a neurologist rather than an internist.¹²⁻¹⁷ Less is known about the impact of urgent neurology consultation in the emergency department (ED) for patients with TIA. Since the availability of neurologists for urgent consultation is often constrained and since the value-added by an urgent neurology consultation is unknown,^{8, 9} better information on the impact of neurology

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consultation on process measures and outcomes is required for policymakers and clinicians to make rational decisions on how to optimize the care for these patients.

Therefore, we conducted a secondary data analysis of a cohort of ED patients diagnosed with TIA to examine associations between neurology consultation and process and outcome measures. Our goals were 1) to examine the factors that were associated with urgent neurology consultation for TIA; 2) to examine the association between neurology consultation and process improvements such as increased use of antithrombotic agents (aspirin, clopidogrel, ticlopidine, heparin, or warfarin), increased use of neuroimaging, increased utilization of anticoagulation for atrial fibrillation; and 3) to examine the association of these process improvements on clinical outcomes as measured by the number of strokes and major adverse events within 90 days of presentation.

2. Methods

We performed a secondary analysis of data from a cohort of patients diagnosed with TIA in the ED from March 1997 to May 1998 within a large managed care plan.² Briefly, patients were identified from a database of ED encounters at 16 Northern California EDs (Sacramento, Santa Rosa, and San Francisco Bay Area) within the Kaiser-Permanente Medical Care (KPMC) system, an integrated health care program. The three million members of KPMC are widely representative of the population of the Northern California region as a whole.¹⁸ All of the EDs included in this study had 24-hour coverage by an on-call neurologist by telephone and for in-person consultation if necessary. Local institutional review boards approved the data collection, abstraction, and data handling procedures for this study.

Patients were identified by a database search of a comprehensive ED visit database for the primary diagnosis of transient ischemic attack. Patients who were not KPMC members, who did not have ED records, who had miscoded diagnoses, or who had a prior TIA during the study period were excluded.²

Demographic and clinical data were abstracted from ED charts, medical records, and clinical databases as previously described.² Briefly, a trained data abstractor blinded to the present analysis abstracted data from clinical databases and medical records with a standardized chart abstraction form. A neurology consultation was defined as any contact by the ED clinicians with an on-call neurologist whether in person or by telephone. An electronic system for imaging reports became available in November 1997, so analysis of the use of neuroimaging was limited to the subgroup of all patients who were seen after that date (n=453).

Patients were followed for 90 days after presentation. Subsequent strokes, TIAs, major cardiovascular events (hospitalization for ventricular arrhythmia, myocardial infarction, congestive heart failure, or unstable angina), and death were identified using a database search of in-network hospitalization and claims records for out-of-network hospitalizations that allowed for near complete ascertainment of outcomes and near complete follow up. Outcomes were adjudicated by independent confirmation by two neurologists who were blinded to the present analysis as previously described.²

Fisher's exact test was used to evaluate univariate associations. A two-sample Wilcoxon rank-sum test was used to compare the median ABCD² score in the consultation and no consultation groups. The ABCD² score is a validated prediction tool that uses five factors to estimate the short-term stroke risk after TIA: age ≥ 60 years (1 point); blood pressure $\geq 140/90$ mmHg (1); clinical features of unilateral weakness (2) or speech impairment without weakness (1); duration ≥ 60 minutes (2) or 10-59 minutes (1); and diabetes (1).¹⁹

Multivariable analysis was performed using generalized estimating equations to account for clustering by facility and using the raw ABCD² score to adjust for the baseline risk of stroke for each patient. The cumulative incidence of stroke and major adverse events was estimated using survival analysis with censoring of patients at death, carotid endarterectomy, or loss to follow-up. The log-rank test was used for comparisons between groups. All data were analyzed using the Stata statistical package (version 9, StataCorp, College Station, Texas).

3. Results

Frequency of Neurology Consultation

In this cohort from 1997-8, an in-person or telephone consultation with a neurologist was obtained for 474 (28%) of the 1,707 patients. Most (414 or 87%) of these neurology consultations were by telephone only; 60 patients were evaluated by a neurologist in-person while in the ED. Consultation rates varied from 6.2% to 44.9% among the 16 facilities studied. Patients who presented to the ED between 8 a.m. and 5 p.m. on non-holiday weekdays were more likely to have a neurology consultation than those who were evaluated after-hours, on weekends, or on holidays (31% vs. 26%, $p=0.03$).

Demographic Characteristics, Risk Factors, and Clinical Presentation

Median age was comparable in the consultation and no consultation groups (Table 1). Blacks were less likely to have a neurology consultation; 20% of black TIA patients had a neurology consultation compared with 29% of white TIA patients ($p=0.01$). There was significant variation in proportion of TIA patients who were black (range 2% to 37%) and the proportion of TIA patients who had a consultation (range 6% to 45%) by site. A quarter (25%) of male TIA patients had a neurology consultation compared to 31% of female TIA patients ($p<0.01$). Vascular risk factors were common overall; hypercholesterolemia was more common in the consultation group (18% vs. 13%, $p=0.01$). Consultation patients were more likely to be already taking aspirin at presentation (41% vs. 30%, $p<0.001$).

We compared baseline history and examination findings as an exploratory analysis of factors that might predict consultation status. Patients with sensory symptoms and vision changes were more likely to have a consultation and patients with a history of confusion were less likely to have a neurology consultation. Consultation patients were more likely to have weakness by exam or symptoms that were still present at presentation to the ED. The presence of a carotid bruit was associated with neurology consultation although the presence or absence of a bruit was documented for only 53% of patients. However, some factors included in the ABCD² score (such as symptoms lasting more than 10 minutes, changes in speech, report of weakness, vertigo, or gait difficulties) were not associated with consultation (Table 1).

The median ABCD² score was similar for patients who had a neurology consultation (median ABCD² score = 4) and patients who did not (Wilcoxon rank-sum $p=0.72$; Figure 1).

Hospital Admissions, Utilization of Diagnostic Tests, and Medications

After excluding patients who had a stroke in the ED prior to hospital admission, patients who had a neurology consultation were more likely to be admitted to the hospital (18% vs. 14%, OR 1.36 [1.01-1.81], $p=0.04$). This association persisted even after adjustment for ABCD² score and for clustering by facility (adjusted OR=1.35, 95% CI 1.02-1.78, $p=0.04$). The overall use of diagnostic tests was similar in the two groups (Table 2). For example, electrocardiograms (ECG) and echocardiograms were obtained in a similar proportion of patients in the two groups.

Data on neuroimaging studies was only available for all patients seen after November 1997 when an electronic imaging reports system became available (n=453). For this subgroup, a similar proportion of patients had head computed tomography (CT) or brain magnetic resonance (MR) imaging within the first 48 to 72 hours. Finally, the proportion of patients who had carotid ultrasounds within one week was also similar in the consult and no consult groups (Table 2).

Patients with neurology consultation were more likely discharged on antithrombotic therapy (92% vs. 87%, OR 1.91 [1.22-2.98], p=0.004). This association persisted after adjusting for ABCD² score and clustering by facility (adjusted OR=1.87, [1.22-2.87], p=0.004). Among the subgroup of patients who were not already taking antithrombotics at the time of presentation (n=951), consultation patients were still more likely to be placed on antithrombotic therapy than those who were not evaluated by neurologists (89% vs. 84%, OR 1.60 (1.01-2.54), p=0.04; adjusted OR 1.58 (1.04-2.40), p=0.03).

For the subgroup of patients with a previous history of atrial fibrillation or with new atrial fibrillation diagnosed on electrocardiogram (n=179), the percentage of patients discharged on anticoagulation (46% vs. 48% in the no consult group, p=1.00) or on any antithrombotic therapy (88% vs. 89% in the no consult group, p=0.78) was comparable.

Stroke, Major Cardiovascular Events, and Adverse Outcomes

At one week, the probability of stroke-free survival and of adverse-event free survival (stroke, major cardiovascular events, or death) was lower with neurology consultation (5.3% vs. 7.5%, p=0.01; and 5.3% vs. 7.8%, p=0.02 respectively). But at 90 days the magnitude of this difference was smaller and was not statistically significant (9.9% vs. 11.0% for stroke, p=0.41; 11.6% vs. 13.6% for adverse events, p=0.48; Figure 2).

4. Discussion

In this cohort drawn from a large integrated health care program in 1997-8, neurology consultation for TIA was uncommon overall (28%) and in-person consultation was rare (4% overall). Previous studies that captured only in-person consultations rather than telephone consultations and have reported rates ranging from 8% in a cohort of TIA and stroke patients in an urban ED²⁰ to 29% of TIA patients in a rural ED that would otherwise be considered neurologically underserved.²¹ Our analysis reflects practice patterns that existed before the risks of stroke after TIA were more widely appreciated, but more recent data reflecting current practice for consultation for TIA has not been widely reported.

The decision to consult a neurologist from the ED is a complex one. We did find that patients who were at higher risk for stroke were not the ones who were targeted for urgent neurological evaluation; indeed there was no relationship between a higher risk of stroke as predicted by the ABCD² score and more frequent urgent neurology consultation. This finding underscores the potential value of this prognostic tool to help guide clinical decision-making in current practice because reliable and validated methods for identifying high-risk TIA patients were not available during the study period.

Instead, the decision about whether to obtain a neurology consultation from the ED appeared to rely on other factors that were independent of risk. Such factors may include institutional norms and local practice patterns, the availability of an on-call neurologist, and the perceived value-added by a consultation in the acute setting. Other factors might include clinical uncertainty rather than acuity since patients who were perceived to be low-risk, but where the diagnosis was uncertain may have targeted for consultation (e.g. patients with migraine on the differential diagnosis). But our cohort was limited to only those patients

who had a final ED diagnosis of TIA. Alternatively, certain higher-risk patients may have been targeted for consultation only if management was uncertain. For instance, patients who were already taking aspirin were more likely to have consultations (e.g. patients having possible vascular events while on antiplatelet therapy ["aspirin-failures"]). ED clinicians could have been seeking advice on alternative antithrombotic therapy for these patients. The racial and sex disparities in consultation requests that we observed were more difficult to explain, though they parallel previously described disparities in referral patterns and inpatient treatment of TIA²² and for stroke^{23, 24} and merit further study. These comparisons of baseline characteristics by consultation status are exploratory in nature and may represent hypotheses for future study.

Given the lack of a clear association between patient acuity and consultation, it is not unexpected that we found only weak associations between consultation and improved process of care measures for TIA. The main areas of associated improvements were in more frequent use of antiplatelet and anticoagulation therapy and in higher rates of hospital admission, both of which have the potential to impact patient outcomes. Our study is unable to distinguish between whether the decision to prescribe antithrombotics or to admit the patient was made prior to consultation or as a consequence of consultation. But these associations did not appear to be simply a marker for more intensive management for consultation patients generally. Although utilization of diagnostic testing for patients with TIA overall may be different today, we found no clear association between consultation and the use of brain imaging, ECGs, and carotid ultrasound, or on the use of anticoagulation for cases of atrial fibrillation, which was comparable to nationally reported rates.²⁶ To the extent that utilization of diagnostic testing is a process measure that may be important for improvement in outcomes, this finding would be expected to attenuate any observed differences in outcomes by consultation status.

Previous studies examining the impact of neurologists have largely focused on stroke rather than TIA. Here the evidence has been conflicting. Some studies have suggested that timely neurological attention is associated with better outcomes¹³⁻¹⁷ and shorter hospitalizations.²⁵ However, a more recent analysis that accounted for differences in the initial prognosis for patients treated by neurologists versus internists has brought some of these conclusions into question.¹² These studies highlight the difficulty of identifying an independent effect of neurologists on clinical outcomes within the milieu of heterogeneous practice patterns.

Given that the ABCD² score was similar in the two groups, one would expect that the observed incidence of subsequent stroke would also be similar. In fact we found that during the first week, when the risk for stroke after TIA is highest, the probability of stroke and of adverse outcomes was lower for consultation patients. But by 90 days, although we observed a 1.1% lower absolute incidence of stroke and a 2% lower absolute incidence of adverse events with consultation, the overall magnitude of this difference was smaller as compared to the initial period and did not meet statistical significance. The heterogeneous nature of neurology consultation, particularly during the study period when there was less consensus on optimal management, as well as the additional impacts of subsequent inpatient and outpatient management decisions would both serve to dilute the potential impact of consultation on longer-term outcomes.

Several limitations of our study are important to consider in interpreting these findings. First, consultations were obtained in the period before the urgent risks of TIA were widely appreciated and before there was a greater consensus on optimal management of TIA. Also practice patterns in a large integrated health care program may not reflect current practice in other clinical settings. Both of these factors limit generalizability to current practice. Second, since our analysis was focused only on urgent neurology consultations from the ED, in-

patient neurology consultations that took place after hospital admission or in follow-up were not captured. This effective “crossover” of patients from the no consultation to the consultation group could lead to an underestimation of the impact of consultation and could explain the discrepancy between the one-week and the 90-day outcomes that was observed. Third, important prognostic differences between the two groups that influenced the decision on consultation may not have been captured, particularly since patients who had a neurology consultation and were not given the final diagnosis of TIA would not be captured in our cohort. The important potential role of neurologists in helping to identify patients who did *not* have a TIA cannot be addressed with the current study. Potential for confounding by indication akin to that encountered in similar studies of stroke patients is possible as well,¹² though we attempted to mitigate the effects of prognostic differences in the groups by using the validated ABCD² score. Nonetheless, other unmeasured confounders may limit the validity of inferences drawn from our analysis. Fourth, the specific content of the consultation and the changes in management that are directly attributable to the neurology consultation was not available. Finally, as a secondary analysis and an observational study, multiple comparisons and subgroup analysis may limit interpretation of our findings beyond hypothesis-generating exploratory analysis.

In summary, we found that during a period before the widespread appreciation of the risks of stroke after TIA, urgent neurology consultation was not targeted to patients who were at highest-risk for stroke. Although we found that urgent neurology consultation was associated with modest improvements early patient outcomes, these associations did not persist at 90 days. Here we present a snapshot and exploratory analysis of previous practice patterns that may form the basis for comparisons to current practice and may serve to highlight the importance of determining the particular processes of care that have the most impact on clinical outcomes. Current practice in terms of diagnostic testing, neurology consultation, and use of antithrombotic medications is likely to have changed and it is possible that neurology consultation may be more valuable today with a greater consensus on the optimal acute management of TIA,²⁷⁻²⁹ a greater recognition of the impact of aggressive early interventions,^{3,4} and an emphasis on developing specific quality measures by health care funding agencies, accreditation organizations, and professional groups.³⁰

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Figure 1.

Figure 2.

TABLE 1

Characteristics of Patients with TIA at Presentation to the ED

Patient Variable	All Patients n=1707 No. (%)	Consultation n=475 No. (%)	No Consultation n=1232 No. (%)	p
Demographics				
Age > 60 years	1325 (78)	354 (75)	971 (79)	0.06
Male Sex	899 (53)	226 (48)	673 (55)	<0.01
Ethnicity*				
White	1226 (80)	360 (76)	866 (70)	ref.
Black	150 (10)	29 (6)	121 (10)	0.01
Asian	86 (6)	22 (5)	64 (5)	0.56
Hispanic	72 (5)	15 (3)	57 (5)	0.13
Risk Factors				
Diabetes Mellitus	332 (19)	78 (16)	254 (21)	0.06
Hypertension	988 (58)	271 (57)	717 (58)	0.70
Coronary Artery Disease	414 (24)	115 (24)	299 (24)	0.99
Atrial Fibrillation	151 (9)	36 (8)	115 (9)	0.30
Carotid Disease	97 (6)	36 (8)	61 (5)	0.05
TIA in Last Three Months	286 (17)	88 (19)	198 (16)	0.25
Prior Stroke	385 (23)	99 (21)	286 (23)	0.30
Hypercholesterolemia	250 (15)	87 (18)	163 (13)	0.01
Current Cigarette Use†	200 (14)	63 (16)	137 (14)	0.45
Congestive Heart Failure	114 (7)	24 (5)	90 (7)	0.11
Medications				
Aspirin	567 (33)	195 (41)	372 (30)	<0.001
Ticlopidine	59 (4)	21 (4)	38 (3)	0.18
Warfarin	153 (9)	35 (7)	118 (10)	0.16
TIA Symptoms				
Duration > 10 minutes‡	1405 (84)	391 (84)	1015 (84)	0.88
Weakness	784 (46)	232 (49)	552 (45)	0.14
Any Sensory Symptoms	684 (40)	224 (47)	460 (37)	<0.001

Patient Variable	All Patients n=1707 No. (%)	Consultation n=475 No. (%)	No Consultation n=1232 No. (%)	p
Confusion	367 (21)	76 (16)	291 (24)	<0.001
Change In Vision	222 (13)	75 (16)	147 (12)	0.04
Change in Speech	722 (42)	195 (41)	527 (43)	0.55
Dizziness	349 (20)	95 (20)	254 (21)	0.84
Vertigo	54 (3)	17 (4)	37 (3)	0.54
Gait Difficulties	430 (25)	127 (27)	303 (25)	0.38
Symptoms in ED	854 (50)	263 (55)	591 (48)	0.007
TIA Exam Findings				
Heart Rate > 80 bpm [§]	688 (40)	174 (37)	514 (42)	0.06
Systolic BP ≥ 140 mm Hg ^{//}	1281 (75)	356 (75)	925 (75)	0.99
Diastolic BP ≥ 90 mm Hg ^{//}	516 (30)	149 (31)	367 (30)	0.52
Murmur	117 (7)	29 (6)	88 (7)	0.52
Bruit [#]	71 (4)	33 (12)	38 (6)	0.003
Weakness	273 (16)	101 (21)	172 (14)	<0.001
Numbness	123 (7)	42 (9)	81 (7)	0.12
Gait Disturbance	83 (5)	27 (6)	56 (5)	0.32
Speech Deficit	168 (10)	54 (11)	114 (9)	0.20
Aphasia	65 (4)	25 (5)	40 (3)	0.07
Dysarthria	100 (6)	29 (6)	71 (6)	0.82

* n=1535,

[†] n=1385,

[‡] n=1670,

[§] n=1702,

^{//} n=1704,

[#] n=904

TABLE 2

Utilization of Diagnostic Studies

Study	All Patients No. (%)	Consultation No. (%)	No Consultation No. (%)	p
Cardiac Evaluation	n=1707	n=475	n=1232	
Electrocardiogram done	1364 (80)	388 (82)	977 (79)	0.28
Echocardiogram				
within one week	63 (4)	17 (4)	46 (4)	0.99
within thirty days	109 (6)	33 (7)	76 (6)	0.58
Head/Neck Imaging	n=453	n=139	n=314	
Head CT				
within 48 hours	325 (72)	98 (71)	227 (72)	0.74
within 72 hours	325 (72)	98 (71)	227 (72)	0.74
Brain MRI				
within 48 hours	5 (1)	1 (1)	4 (1)	0.99
within 72 hours	11 (2)	3 (2)	8 (3)	0.99
Carotid Ultrasound				
within one week	105 (23)	27 (19)	78 (25)	0.23
within thirty days	179 (40)	50 (36)	129 (41)	0.35

TABLE 3

Treatment and Disposition

Treatment	All Patients No. (%)	Consultation No. (%)	No Consultation No. (%)	P
Patients Not on Antithrombotics	n=952	n=231	n=721	
Started on Antiplatelet Agent	788 (83)	196 (85)	592 (82)	0.37
Started on Anticoagulation	33 (3)	19 (8)	14 (2)	<0.001
Started on Any Antithrombotic	809 (85)	206 (89)	603 (84)	0.04
Patients with Atrial Fibrillation	n=179	n=41	n=138	
On Anticoagulation at Discharge	85 (47)	19 (46)	66 (48)	0.99
On Any Antithrombotic at Discharge	159 (89)	36 (88)	123 (89)	0.78
Patient Disposition	n=1644	n=461	n=1183	
Admitted to Hospital	242 (15)	81 (18)	161 (14)	0.04