Predictors of Hospitalization in Patients With Transient Ischemic Attack or Minor Ischemic Stroke

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ABSTRACT: **Background:** Transient ischemic attack (TIA) and minor stroke are associated with a substantial risk of subsequent stroke; however, there is uncertainty about whether such patients require admission to hospital for their initial management. We used data from a clinical stroke registry to determine the frequency and predictors of hospitalization for TIA or minor stroke across the province of Ontario, Canada. **Methods:** The Ontario Stroke Registry collects information on a population-based sample of all patients seen in the emergency department with acute stroke or TIA in Ontario. We identified patients with minor ischemic stroke or TIA included in the registry between April 1, 2008, and March 31, 2011, and used multivariable analyses to evaluate predictors of hospitalization. **Results:** Our study sample included 8540 patients with minor ischemic stroke or TIA, 47.2% of whom were admitted to hospital, with a range of 37.6% to 70.3% across Ontario’s 14 local health integration network regions. Key predictors of admission were preadmission disability, vascular risk factors, presentation with weakness, speech disturbance or prolonged/persistent symptoms, arrival by ambulance, and presentation on a weekend or during periods of emergency department overcrowding. **Conclusions:** More than one-half of patients with minor stroke or TIA were not admitted to the hospital, and there were wide regional variations in admission patterns. Additional work is needed to provide guidance to health care workers around when to admit such patients and to determine whether discharged patients are receiving appropriate follow-up care.

RÉSUMÉ: Variables prédictives d’hospitalisation chez des patients victimes d’une ischémie cérébrale transitoire ou d’un AVC mineur. **Contexte:** Une ischémie cérébrale transitoire (ICT) et un AVC mineur sont associés au risque notable d’être victime d’un autre AVC. Il subsiste cependant des doutes quant à la nécessité d’hospitaliser des patients pour un suivi initial. Nous avons donc utilisé les données d’un registre clinique concernant les AVC pour déterminer la fréquence et les variables prédictives d’une hospitalisation à la suite d’une ICT ou d’un AVC mineur partout en Ontario (Canada). **Méthodes:** Le Registre de l’AVC de l’Ontario recueille des données au sein d’un échantillon représentatif composé de tous les patients examinés dans un service d’urgence ontarien à la suite d’une ICT ou d’un AVC mineur. Nous avons ainsi identifié les patients victimes d’une ICT et d’un AVC mineur inclus dans le registre entre le 1er avril 2008 et le 31 mars 2011. Nous avons ensuite procédé à des analyses multi-variables afin d’évaluer les variables prédictives d’une hospitalisation. **Résultats:** L’échantillon visé par notre étude incluait 8540 patients victimes d’une ICT ou d’un AVC mineur ; sur ce total, 47,2% ont été hospitalisés, les pourcentages variant de 37,6% à 70,3% dans les 14 Réseaux locaux d’intégration des services de santé (RLISS) de l’Ontario. Les principales variables prédictives d’une hospitalisation se sont révélées être un handicap antérieur à cette hospitalisation, des facteurs de risque vasculaire, des signes de faiblesse, des troubles de la parole ou des symptômes persistants et prolongés de ces troubles, une arrivée en ambulance et une visite à l’hôpital les fins de semaine ou lorsque les services d’urgence sont encombrés. **Conclusions:** Plus de la moitié des patients victimes d’un AVC mineur ou d’une ICT n’a pas été hospitalisée. Qui plus est, on peut noter de fortes variations régionales en ce qui regarde la tendance à l’hospitalisation. Il est aussi nécessaire de fournir au personnel de la santé des lignes directrices pour savoir s’il est nécessaire ou non d’hospitaliser tels patients et si ceux ayant obtenu leur congé bénéficient d’un suivi adéquat.

Keywords: Health Services Research, hospitalization, registries, stroke, TIA, transient ischemic attack
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Transient ischemic attack (TIA) is associated with a substantial short-term risk of recurrent stroke. Although observational studies suggest that prompt assessment and risk factor modification can reduce the risk of subsequent stroke, there is an ongoing debate about the relative merits and disadvantages of hospitalization versus outpatient care in such patients.

Prediction scores have been developed to estimate the risk of recurrent stroke; these generally incorporate clinical factors (age, comorbid conditions) and presenting symptoms (weakness, speech disturbance, duration of symptoms), with some scores also including the results of initial brain or vascular imaging. Although many clinical practice guidelines recommend hospitalization for patients with risk scores above a certain cutoff (typically an age, blood pressure, clinical features, duration of symptoms [ABCD2 score > 2 or 3]), such risk scores may perform less well than the initial validation studies suggested, contributing to further uncertainty about when to hospitalize patients with minor stroke or TIA.

We used data from a clinical stroke registry in Ontario, Canada, linked with administrative databases, to determine the association between patient and system-level factors with the proportion of patients with TIA or minor stroke admitted to hospital. We hypothesized that both patient-level factors (such as presenting symptoms and comorbid conditions) and system-level factors (such as availability of a stroke prevention clinic) would be associated with hospitalization.

METHODS

Data Sources and Study Sample

The Ontario Stroke Registry (formerly known as the Registry of the Canadian Stroke Network) performs a biennial audit on a population-based random sample of patients seen at all acute care institutions in Ontario. Events are reviewed by trained neurology research personnel and only included in the registry database if chart review confirms a diagnosis of stroke or TIA. The registry database includes information on stroke type and severity, presenting symptoms and comorbid conditions, and validation by duplicate chart abstraction has shown almost perfect agreement (kappa scores of >0.80) for key variables including age, sex, stroke type, admission to hospital, and the diagnoses of diabetes and hypertension and substantial agreement (kappa scores of 0.61-0.80) for presenting symptoms (unpublished data). For the present study, we included all patients with TIA (defined as transient focal neurological symptoms of less than 24 hours duration, with no evidence of infarction on neuroimaging) or minor ischemic stroke (defined as a Canadian Neurological Scale score of greater than 10, corresponding to a National Institutes of Health Stroke Scale score of <3) who were aged 18 years or older and who were seen in the emergency department (ED) or admitted to hospital between April 1, 2008, and March 31, 2009, or April 1, 2010, and March 31, 2011. For patients with more than one ED presentation during the study period, only the first event was included.

The Ontario Stroke Registry is housed at the Institute for Clinical Evaluative Sciences (ICES) where it is linked to population-based administrative databases using unique encoded patient identifiers. We used the National Ambulatory Care Reporting System database to identify times of ED overcrowding, defined as a mean length of stay in the ED of greater than 4 hours for patients of similar acuity seen in the ED on the same shift as the index patient, the 2010 Canada Census to provide information on socioeconomic status based on median neighbourhood income for each patient and the 2010 Stroke Secondary Prevention Clinic Resource Survey to provide information on the characteristics of stroke prevention clinics.

Analysis

We determined the proportion of patients admitted to hospital in the overall cohort, in the subgroups with TIA alone and minor ischemic stroke alone, and by region, based on Ontario’s 14 Local Health Integration Network regions. We compared baseline characteristics between admitted and discharged patients using chi-square tests for categorical variables and the Wilcoxon rank-sum test for continuous variables.

We used multiple logistic regression to evaluate the effect of the following predictor variables on the odds of hospital admission: (1) patient characteristics (age, sex, place of residence before admission, rural residence, neighbourhood income group, prestroke functional status, and comorbid conditions [defined by having documentation of any of these in the patient chart] including diabetes mellitus, hypertension, smoking, atrial fibrillation, and coronary artery disease); (2) characteristics of the index event (motor or speech deficits, duration of symptoms, systolic blood pressure >140 mm Hg on presentation, diastolic blood pressure >90 mm Hg on presentation, ABCD2 score); (3) characteristics of the care encounter (ED overcrowding, presentation off-hours); and (4) hospital characteristics (hospital size, designation as a stroke centre, availability of a stroke unit, presence of a stroke prevention clinic on-site, and number of days of operation of the stroke prevention clinic) and health region of care. We used a hierarchical logistic regression that incorporated hospital-specific and region-specific random effects to account for the clustering of patients within hospitals and regions. We used variance partition coefficients to describe the percentage of variation in the odds of admission that could be attributed to the patient level versus institutional and regional levels.

Ethics

Chart review for the Ontario Stroke Registry (OSR) is done without patient consent because ICES is named as a prescribed entity under provincial privacy legislation. This study was approved by the Sunnybrook Health Sciences Centre Research Ethics Board.

RESULTS

The study sample consisted of 8540 patients seen in the ED with TIA or minor ischemic stroke between April 1, 2008, and March 31, 2011. Overall, 4030 (47.2%) were admitted to hospital. Baseline characteristics of participants are shown in Table 1.

In the multivariable analyses, significant predictors of hospital admission were disability before admission (adjusted odds ratio [AOR], 2.20; 95% confidence interval [CI], 1.75-2.76), diabetes (AOR, 1.14; 95% CI, 1.00-1.29), hypertension (AOR, 1.15; 95% CI, 1.02-1.31), smoking (AOR, 1.05; 95% CI, 1.05-1.46), atrial fibrillation (AOR, 1.71; 95% CI, 1.47-1.99), presentation with weakness (AOR, 1.17; 95% CI, 1.05-1.31), speech disturbance (AOR, 1.38; 95% CI, 1.22-1.56) or prolonged/persistent symptoms (AOR, 3.05; 95% CI, 2.18 2.76), arrival by ambulance (AOR, 2.45;
<table>
<thead>
<tr>
<th>Index event</th>
<th>Discharged N = 4510</th>
<th>Admitted N = 4030</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIA</td>
<td>3824 (85)</td>
<td>1683 (42)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stroke</td>
<td>686 (15)</td>
<td>2347 (58)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>2189 (48)</td>
<td>1925 (48)</td>
<td>0.48</td>
</tr>
<tr>
<td>Median age, years (IQR)</td>
<td>73 (63-82)</td>
<td>75 (64-83)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rural residence</td>
<td>778 (17)</td>
<td>671 (17)</td>
<td>0.46</td>
</tr>
<tr>
<td>Income quintile*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 (lowest)</td>
<td>849 (19)</td>
<td>872 (22)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>936 (21)</td>
<td>798 (20)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>887 (20)</td>
<td>789 (20)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>981 (22)</td>
<td>749 (19)</td>
<td></td>
</tr>
<tr>
<td>5 (highest)</td>
<td>827 (18)</td>
<td>798 (20)</td>
<td></td>
</tr>
<tr>
<td>Long-term care residence</td>
<td>37 (1)</td>
<td>32 (1)</td>
<td>0.89</td>
</tr>
<tr>
<td>Disabled before event (mRS 35)</td>
<td>228 (5)</td>
<td>424 (10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1022 (23)</td>
<td>1108 (28)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2820 (52)</td>
<td>2849 (71)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>1770 (39)</td>
<td>1775 (44)</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>567 (13)</td>
<td>663 (16)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dementia</td>
<td>261 (6)</td>
<td>248 (6)</td>
<td>0.47</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>488 (11)</td>
<td>677 (17)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>988 (22)</td>
<td>1046 (26)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prior stroke/TIA</td>
<td>1129 (25)</td>
<td>976 (24)</td>
<td>0.38</td>
</tr>
<tr>
<td>SBP ≥190</td>
<td>398 (9)</td>
<td>453 (11)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DBP ≥90</td>
<td>1070 (24)</td>
<td>1146 (28)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Weakness</td>
<td>2182 (48)</td>
<td>2316 (58)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Speech disturbance</td>
<td>1608 (36)</td>
<td>1650 (41)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Symptoms persisting ≥60 minutes</td>
<td>2019 (45)</td>
<td>3220 (80)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ABCD² score ≥2</td>
<td>4133 (92)</td>
<td>3927 (97)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Transported by ambulance</td>
<td>1651 (37)</td>
<td>2239 (56)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Presentation on overcrowded ED shift*</td>
<td>3270 (72)</td>
<td>3040 (75)</td>
<td>0.002</td>
</tr>
<tr>
<td>Time from symptom onset to ED arrival</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>&lt;6 hours</td>
<td>2679 (59)</td>
<td>2085 (52)</td>
<td></td>
</tr>
<tr>
<td>6-24 hours</td>
<td>1094 (24)</td>
<td>1102 (27)</td>
<td></td>
</tr>
<tr>
<td>&gt; 24 hours</td>
<td>737 (16)</td>
<td>843 (21)</td>
<td></td>
</tr>
<tr>
<td>Presentation midnight to 0800 hours</td>
<td>326 (7)</td>
<td>366 (9)</td>
<td>0.001</td>
</tr>
<tr>
<td>Weekend presentation</td>
<td>1149 (26)</td>
<td>1148 (28)</td>
<td>0.002</td>
</tr>
<tr>
<td>Hospital designation</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Regional stroke centre</td>
<td>1218 (27)</td>
<td>1330 (33)</td>
<td></td>
</tr>
<tr>
<td>District stroke centre</td>
<td>1395 (31)</td>
<td>1304 (32)</td>
<td></td>
</tr>
<tr>
<td>Nondesignated centre</td>
<td>1897 (42)</td>
<td>1396 (35)</td>
<td></td>
</tr>
</tbody>
</table>

IQR, interquartile range; DBP, diastolic blood pressure; ED, emergency department; mRS, modified Rankin score; SBP, systolic blood pressure; TIA, transient ischemic attack.

*Neighbourhoods were divided into quintiles based on median income from 2006 Canada Census data, in which quintile 1 represents the lowest and quintile 5 the highest income quintile. An overcrowded ED shift was defined as one in which the mean ED length of stay was greater than 4 hours for patients of similar acuity seen in the same ED shift as the index patient.
95% CI, 2.18-2.76), and presentation on a weekend (AOR, 1.14; 95% CI, 1.01-1.29) or during period of ED overcrowding (AOR, 1.26; 95% CI, 1.06-1.50) (Figure 1). Presentation with TIA rather than minor stroke was associated with a reduced odds of admission (AOR, 0.15; 95% CI, 0.13-0.17). Age, sex, neighbourhood income, rural residence, time from symptom onset to hospital arrival, hospital designation (regional or district stroke centre), and teaching status were not significant predictors of admission.

Figure 1: Forest plot of predictors of admission in patients with TIA and minor stroke.
admission, nor was the presence of a stroke unit or a stroke pre-
vention clinic on-site (Figure 1). Results were similar when the
subgroups with minor stroke and TIA were analyzed separately (data
not shown).

There were variations in the proportion of patients admitted
across regions, from a low of 37.5% to a high of 70.3%. After
adjusting for patient, hospital, and regional characteristics, 88.4% of
the remaining variation was due to between-patient variation, 11% was due to between-hospital variation, and 0.6% was due to
between-region variation.

**DISCUSSION**

In this contemporary population-based study, more than
one-half of patients seen in the ED across the province of Ontario
with TIA or minor ischemic stroke were not admitted to hospital,
and there were wide regional variations in the proportion of
patients admitted.

We found that the key predictors of hospital admission were
predominantly dependence and vascular risk factors as well as
high-risk presenting features such as weakness, speech
disturbance, or prolonged/persistent symptoms. This likely
reflects clinical decision-making based on the need to manage
comorbid conditions as well as the use of prognostic scores such as
the ABCD² score to determine whether patients should be
admitted or discharged. However, the uneven performance of
such scoring systems suggests a need for updated strategies to
guide decisions about admission of patients with minor stroke and
TIA. More recent risk prediction scores that incorporate the
findings of initial imaging and other investigations may improve
patient risk stratification.

Studies from the United States have also documented
admission rates for TIA in the range of 54% to 91%, with regional
variations, although one study of patients seen in the era
before publication of risk prediction tools found that only 14% of
patients with TIA were admitted, and that admission only weakly
 correlated with the ABCD² score. Another study using data
from the National Emergency Department Sample evaluated
predictors of hospitalization and found that, after adjustment for
age and comorbid conditions, higher median household income,
Medicare insurance type, and care at a teaching hospital were all
associated with hospitalization, suggesting that some
between income and hospitalization, may not be generalizable to
other settings. However, our study strengths include the use of
data from a large, population-based provincial registry with
detailed information on presenting characteristics.

In summary, we found that almost one-half of patients seen in
the ED with TIA and minor stroke were admitted to hospital.
Although clinical factors such as comorbid conditions and
presenting symptoms were the strongest predictors of admission,
system factors such as presentation off-hours and on weekends
were also associated with hospitalization, suggesting that some
admissions could be avoided through improved access to
outpatient care. Future activities should focus on updating clinical
practice recommendations to provide more guidance on which
patients with TIA/minor stroke warrant admission, and on devolv-
ing and implementing appropriate alternatives to inpatient care.

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DISCLOSURES

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REFERENCES