Stroke Among Patients With Dizziness, Vertigo, and Imbalance in the Emergency Department
A Population-Based Study

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Background and Purpose—Dizziness, vertigo, and imbalance are common presenting symptoms in the emergency department. Stroke is a leading concern even when these symptoms occur in isolation. The objective of the present study was to determine the “real-world” proportion of stroke among patients presenting to the emergency department with these dizziness symptoms (DS).

Methods—From a population-based study, patients >44 years of age presenting with DS to the emergency department, or directly admitted to the hospital, were identified. Demographics, the frequency of new cerebrovascular events, and the frequency of isolated DS (ie DS with no other stroke screening term or accompanying neurologic signs or symptoms) were assessed. Multivariable logistic regression was used to evaluate the association of age, gender, ethnicity, and isolated DS with stroke/transient ischemic attack (TIA). The association of the presenting symptoms with stroke/TIA was also assessed.

Results—Stroke/TIA was diagnosed in 3.2% (53 of 1666) of all patients with DS. Only 0.7% (9 of 1297) of those with isolated DS had a stroke/TIA. Patients with stroke/TIA were slightly older than those without stroke/TIA (69.3±11.7 vs 65.3±12.9, P=0.02). Male gender was associated with stroke/TIA, whereas isolated DS was negatively associated with stroke/TIA. Patients with imbalance (dizziness as referent) were more likely to have stroke/TIA.

Conclusions—The proportion of cerebrovascular events in patients presenting with dizziness, vertigo, or imbalance is very low. Isolated dizziness, vertigo, or imbalance strongly predicts a noncerebrovascular cause. The symptom of imbalance is a predictor of stroke/TIA. (Stroke. 2006;37:2484-2487.)

Key Words: cerebrovascular accident ■ dizziness ■ gait disorders ■ population surveillance ■ vertigo

An estimated 7.5 million patients with dizziness are seen each year in ambulatory care settings in the United States, making it one of the most common principal complaints in the emergency department (ED).1

The term “dizziness” is very nonspecific but may refer to vertigo, lightheadedness, presyncope, anxiety, or just not feeling well.2–6 Although some physicians consider imbalance to be a more serious symptom of neurologic disease, it is also considered by many authors to be a type of dizziness.2–6 Some patients have difficulty describing their specific type of dizziness and oftentimes physicians do not attempt to differentiate among these types.7 Although the most common causes are benign,2,4 the differential diagnosis includes potentially life-threatening stroke. In the acute setting, cerebellar or brain stem infarction must be a leading concern because hydrocephalus or recurrent stroke could follow.8,9 Although other focal neurologic symptoms may accompany dizziness,10,11 case reports and small series have shown that dizziness can also be the principal or only complaint in patients with stroke.12–19 However, to date, no large population-based study has investigated the frequency of stroke among patients presenting to the ED with dizziness.

From a large population-based study, the Brain Attack Surveillance in Corpus Christi (BASIC) project, we sought to determine the “real-world” proportion of stroke/transient ischemic attack (TIA) in patients presenting to the ED with a primary complaint of dizziness or specific types of dizziness (ie vertigo and imbalance).2–6

Methods

The methods of the BASIC project were previously reported.20 This population-based study is an ongoing stroke surveillance study in Nueces County, Texas. All but 5% of the 313,645 residents of Nueces County live in the city of Corpus Christi and the next closest metropolitan areas (San Antonio and Houston, Texas) are more than

Received June 22, 2006; final revision received July 25, 2006; accepted August 1, 2006.

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Stroke is available at http://www.strokeaha.org

DOI: 10.1161/01.STR.0000240329.48263.0d

2484
150 miles away. Seven acute-care hospitals and no academic medical centers also contribute to making this community ideal for complete case capture of acute medical conditions while avoiding tertiary referral center bias.

Both active and passive surveillance are used to capture all cases of stroke/TIA, including ischemic stroke, nontraumatic intracerebral hemorrhage, and subarachnoid hemorrhage, in subjects over age 44 years in Nueces County, Texas. Active surveillance involves manually searching ED and hospital logs for a large set of previously validated stroke screening terms recorded as the patient’s presenting complaint.21 Included among these are the following indicators of dizziness symptoms (DS): “dizziness,” “vertigo,” and “imbalance.” Passive ascertainment using International Classification of Disease, 9th Revision codes in discharge records is also performed to ensure complete case capture.

Cases are documented by trained abstractors using the medical record. Board-certified neurologists validated all stroke cases after reviewing source documents from the ED and hospital course (if applicable), blinded to subject age and ethnicity, on the basis of previously published international criteria.22 Using these criteria, a diagnosis of TIA was made when symptoms abated within 24 hours. Source documents include the following: treating physician history and physical (including impression and plan), triage records, nursing records, results of any testing ordered, and inpatient hospitalization records, including discharge summaries (if applicable). Information entered into the database for all subjects includes the following: log book screening term, demographics (age, gender, race/ethnicity), focal motor, sensory, language, and visual symptoms documented in the medical record, diagnosis by ED or admitting physician, and discharge disposition. We determined the treating physician’s diagnosis to be stroke/TIA if any mention of stroke/TIA (eg “cerebrovascular accident,” “TIA,” “rule out cerebrovascular accident,” or “rule out TIA”) was recorded in the final impression, a method used previously.23 Stroke risk factors (hypertension, diabetes, atrial fibrillation, coronary artery disease, history of stroke/TIA, high cholesterol, heavy alcohol consumption, and smoking status) are recorded only for patients validated as a stroke/TIA by a BASIC neurologist. Patients presenting between January 1, 2000, and June 30, 2003, to the ED or directly admitted to the hospital with the principal presenting complaint documented in the ED or hospital log of DS, regardless of final diagnosis are the subject of this analysis. Only cases of first presentation with DS screening terms during the study period were included. Isolated DS was defined as “dizziness,” “vertigo,” or “imbalance” with no other stroke screening term and no motor, sensory, language, or visual signs or symptoms.

Statistical Analysis

Frequencies and means with standard deviations were calculated for baseline variables for the stroke/TIA and nonstroke/TIA groups. Baseline characteristics were compared between groups using t tests for continuous variables and χ² tests for categorical variables. Baseline stroke risk factors could not be compared because this information was not recorded in the nonstroke/TIA patients. Discharge disposition was compared using a χ² test. Using the BASIC neurologist’s diagnosis as the gold standard, the proportion of stroke/TIA cases missed in the ED was calculated. The number of patients with isolated DS admitted to the hospital from the ED with a presumed diagnosis of stroke/TIA was also determined.

Multivariable logistic regression was used to identify variables associated with stroke/TIA in those presenting with DS. The number of covariates was limited based on the rule of 10, which requires at least 10 least frequent outcomes for each degree of freedom.24 Variables were prespecified and included age (modeled continuously), gender, ethnicity, and isolated DS. The inclusion of age, gender, and ethnicity in the model adjusts for these important potential confounders when testing the association between isolated DS and stroke.

The associations between the individual DS screening terms and stroke/TIA were also assessed using multivariable logistic regression with dizziness as the referent. Because the term “dizziness” was no longer used as a screening term after March 14, 2001, only subjects identified between January 1, 2000, and March 14, 2001, were available for this specific analysis. Because some patients had two or, rarely, all three screening terms recorded, a hierarchy was established a priori, whereby imbalance was selected over vertigo or dizziness, and vertigo was selected over dizziness when more than one was listed. This hierarchy provides priority to the terms determined to have a higher positive predictive value for stroke cases in this population.21 Statistical analysis was performed using S-plus 7.0 for Windows (Insightful Corp). The Institutional Review Boards of the University of Michigan, the University of Texas at Houston, and each of the Nueces County hospitals approved this project.

Results

During this study period, 1666 patients were identified with the principal presenting complaint of dizziness (885), vertigo (665), imbalance (78), or more than one of these terms (38). Only 3.2% (53 of 1666) of these patients were validated to have a stroke/TIA by a BASIC neurologist based on international criteria22 after thorough review of all source documentation. Of those with a validated stroke/TIA, the principal presenting complaint was dizziness in 23 cases, vertigo in 18 cases, imbalance in 11 cases, and more than one of these terms in one case. Nearly all (1629 of 1666 [98%]) of the patients identified in this study presented to the ED. Of the 46 validated stroke/TIA cases evaluated in the ED, the ED physician did not make a diagnosis of stroke or TIA in 16 cases (35%). Whereas 17% (9 of 53) of those with stroke/TIA had isolated DS, only 0.7% (9 of 1297) of all patients presenting with isolated DS had stroke/TIA diagnosed. Of patients with isolated DS, 15 of 1297 (1%) were admitted to the hospital with a diagnosis of stroke/TIA by the ED or admitting physician; five of these were validated as stroke/TIA. Ischemic strokes were identified in 33 patients, TIA in 17, intracranial hemorrhage in one, and two were of uncertain type because imaging results were not available. The demographics and clinical characteristics of those with and without a diagnosis of stroke/TIA are shown in Table 1. The group with cerebrovascular events were significantly older (69.3±11.7) compared with the nonstroke/TIA group (65.3±12.9, P=0.02). Male gender was more common in the stroke/TIA group compared with the nonstroke/TIA group. There was no significant difference in race/ethnicity between the groups.

Most patients without stroke/TIA had isolated DS (80%). The most common diagnoses in patients without stroke/TIA were dizziness not otherwise specified, peripheral vestibular disorders (eg labyrinthitis, benign positional vertigo), metabolic disturbances (eg anemia, hyperglycemia, electrolyte abnormalities), orthostatic hypotension, anxiety, or dizziness associated with headache.

Patients with stroke/TIA were more likely than patients without stroke/TIA to be admitted to the hospital (75% vs 18%, respectively). Hypertension was the most common stroke risk factor followed by history of coronary artery disease, diabetes, previous TIA/stroke, current smoker, hypercholesterolemia, and atrial fibrillation (Table 1). Most patients with stroke/TIA (72%) had at least two stroke risk factors.

Table 2 provides the results of multivariable logistic regression analysis for potential predictors of stroke. Male gender (odds ratio [OR], 2.47; 95% CI, 1.39–4.40) was associated with stroke/TIA, whereas isolated DS had a strong negative association with stroke/TIA (OR, 0.05; 95% CI, 0.02–0.11). In a
Patients with cerebrovascular events were older, more often male, and most had two or more stroke risk factors. Overall, patients with stroke/TIA identified in the current study had a stroke risk factor profile similar to a previously reported unselected BASIC study stroke population.23 Only a few studies have looked at the proportion of stroke/TIA among patients with DS presenting to the ED.13,26–29 However, all of these are single-center studies with small sample sizes (range, 24–125 patients). Population-based studies facilitate the ability to generalize results beyond individual tertiary referral centers. Proportion of cerebrovascular events varied in previous studies from 2 to 25%. The higher proportion found in some studies is particularly alarming because the presentation of DS is so common. The study reporting the highest proportion of stroke/TIA focused only on subjects with acute-onset vertigo.13 Some physicians may be more concerned about stroke when the specific complaint is vertigo rather than nonspecific dizziness, but previous stroke predictive models did not separate vertigo from dizziness.30 We found vertigo to be no more predictive of stroke/TIA than the less specific term of dizziness, which emphasizes the importance of research into the presentation of dizziness.

Although age was significantly greater in those with stroke/TIA, the absolute difference was only 4 years. This small difference may be the result of our inclusion criterion of age >44 years. If younger subjects were included, this difference may increase because stroke is rare at younger ages whereas dizziness is not.31 Including younger ages would also likely further reduce the already low overall proportion of stroke found among subjects presenting with DS. The difference in gender is consistent with both the established higher age-adjusted risk of stroke among males and the higher frequency of peripheral dizziness among females.31,32

It was not surprising that imbalance was associated with stroke/TIA compared with dizziness, whereas vertigo was not. The most common causes of vertigo and dizziness are benign peripheral vestibular disorders, whereas acute imbalance without vertigo or dizziness is usually caused by a cerebellar stroke, particularly within the superior cerebellar artery distribution33 and not the result of a peripheral vestibular disorder. Vertigo and dizziness can be caused by acute brain stem or cerebellar stroke, but the statistical association of these symptoms with stroke is less than the association of imbalance with stroke as a result of the relative infrequency of stroke causing vertigo or dizziness compared with nonstroke causes (ie peripheral vestibular disorders).

The limitations to this study must be addressed. Like with any observational study, potential for misclassification exists. Most patients were not examined by a neurologist in the ED, and this study was not designed to collect specific features sought by neuro-otology specialists, but rather to report the “real-world” ED experience with this type of acute neurological presentation. As a result, subtle neurologic findings indicating central nervous system dysfunction may have been missed in some patients.34 In addition, brain MRI was not ordered in most patients, and some recent reports have shown small brainstem or cerebellar strokes identified by MRI in patients with clinical presentations closely resembling peripher-

### TABLE 1. Demographic and Clinical Characteristics of Patients With and Without Cerebrovascular Cause of Dizziness, Vertigo, or Imbalance

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Stroke/TIA (n=53)</th>
<th>No Stroke (n=1,013)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean)±SD</td>
<td>69.3±11.7</td>
<td>65.3±12.9</td>
<td>0.02</td>
</tr>
<tr>
<td>Male</td>
<td>29 (55%)</td>
<td>574 (36%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td>0.38</td>
</tr>
<tr>
<td>Non-Hispanic white (%)</td>
<td>21 (40%)</td>
<td>545 (34%)</td>
<td></td>
</tr>
<tr>
<td>Mexican American (%)</td>
<td>31 (58%)</td>
<td>954 (60%)</td>
<td></td>
</tr>
<tr>
<td>Other (%)</td>
<td>1 (2%)</td>
<td>95 (6%)</td>
<td></td>
</tr>
<tr>
<td>Stroke risk factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>38 (72%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>21 (40%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>17 (32%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Previous transient ischemic attack/stroke</td>
<td>15 (28%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>12 (23%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>11 (21%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>3 (6%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Heavy alcohol consumption</td>
<td>0 (0%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Total risk factors ≥2</td>
<td>38 (72%)</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Isolated dizziness symptoms*</td>
<td>9 (17%)</td>
<td>1288 (80%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Motor deficit</td>
<td>31 (60%)</td>
<td>55 (4%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Sensory deficit</td>
<td>15 (31%)</td>
<td>43 (3%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Language disturbance</td>
<td>10 (21%)</td>
<td>20 (1%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Visual changes</td>
<td>12 (24%)</td>
<td>42 (3%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Admitted to hospital</td>
<td>40 (75%)</td>
<td>292 (18%)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

*Isolated dizziness symptoms=dizziness, vertigo, or imbalance without other stroke screening terms or accompanying neurologic signs or symptoms. NA indicates not available.

### TABLE 2. Multivariable Logistic Regression Model of Predictors of Stroke Associated With Dizziness, Vertigo, or Imbalance

<table>
<thead>
<tr>
<th>Covariates</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.02 (1.0–1.04)</td>
</tr>
<tr>
<td>Male gender</td>
<td>2.47 (1.39–4.40)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>0.89 (0.48–1.63)</td>
</tr>
<tr>
<td>Other</td>
<td>0.36 (0.05–2.77)</td>
</tr>
<tr>
<td>Isolated dizziness symptoms*</td>
<td>0.05 (0.02–0.11)</td>
</tr>
</tbody>
</table>

*Isolated dizziness symptoms=dizziness, vertigo, or imbalance without other stroke screening terms or accompanying neurologic signs or symptoms.
eral vestibular disorders. Therefore, it is possible that some patients classified as “no stroke” may have had small strokes that went unidentified clinically. We categorized patients based on the screening terms that were entered into the ED or hospital log at the time of evaluation. Because no standardized definitions for symptom terminology were used by the hospital employees entering principal complaints at the various sites, caution must be taken when interpreting differences among dizzy terms. Also, symptom onset, duration, aggravating/alloiating factors, and associated auditory symptoms or headache were not systematically collected. Thus, these important clinical features could not be compared between groups. We were unable to adjust for stroke risk factors in assessing associations with stroke/TIA because this information was not collected in the nonstroke/TIA patients. Inclusion of these potential confounders may have altered our results. This patient population, including a large proportion of nonimmigrant Hispanic Americans, the United States’ largest minority population, may not be generalizable to all populations.

The strengths of this study are its population-based design and stroke/TIA diagnosis validations by neurologists using standardized criteria and source documentation. Furthermore, this study provides information on “real-world” experience with terminology and clinical presentations in a representative community.

Although the percentage of patients presenting with DS ultimately determined to be caused by stroke is low, when considering how commonly patients with DS present for evaluation, the absolute number of these patients with stroke etiologies may be high. More detailed population-based studies and prospective clinical studies on the relationship of stroke and DS are critically needed so that stroke can be rapidly identified. Establishing clinical predictors of stroke is also crucial to reducing health expenditures and ED waiting times related to this common ED presentation. This study suggests that of the patients presenting with DS, those with other neurologic symptoms, who are older and male, are at the highest risk for a cerebrovascular etiology.

Source of Funding
The study was funded by National Institutes of Health grant RO1 NS38916.

Disclosures
None.

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Stroke. 2006;37:2484-2487; originally published online August 31, 2006;
doi: 10.1161/01.STR.0000240329.48263.0d
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

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