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Definition and Implications of the Preventable Stroke

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Abstract

IMPORTANCE—Although patients with acute stroke are routinely evaluated for potential treatment (ie, treatability of the stroke), preventability of the presenting stroke is generally not seriously considered.

OBJECTIVE—To systematically analyze stroke preventability.

DESIGN, SETTING, AND PARTICIPANTS—We evaluated medical records of 274 consecutive patients discharged with a diagnosis of ischemic stroke between December 2, 2010, and June 11, 2012, at the University of California Irvine Medical Center. Mean (SE) patient age was 67.2 (0.8) years. Data analysis was conducted from July 3, 2014, to August 4, 2015.

EXPOSURES—Medical records were systematically examined for demographic information, stroke risk factors, stroke severity, and acute stroke treatment.

MAIN OUTCOMES AND MEASURES—We defined stroke preventability as the degree to which the patient's presenting stroke was preventable. Using variables easily determined at onset of stroke, we developed a 10-point scale (0, not preventable; 10, most preventable) to classify the degree of stroke preventability. Our focus was effectiveness of treatment of hypertension (0–2 points), hyperlipidemia (0–2 points), and atrial fibrillation (0–4 points), as well as use of antithrombotic treatment for known prior cerebrovascular and cardiovascular disease (0–2 points).

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RESULTS—Total risk scores ranged from 0 to 8 (mean [SE], 2.2 [0.1]), with 207 patients (75.5%) exhibiting some degree of preventability (score of 1 or higher). Seventy-one patients (25.9%) had scores of 4 or higher, indicating that the stroke was highly preventable. Severity of stroke as determined by the National Institutes of Health Stroke Scale score was not related to preventability of stroke. However, 21 of 71 patients (29.6%) whose stroke was highly preventable were treated with intravenous or intra-arterial acute stroke therapy while these treatments were provided for only 13 of 67 patients (19.4%) with scores of 0 (no preventability) and 19 of 136 patients (14.0%) with scores of 1 to 3 (low preventability) ($P = .03$).

CONCLUSIONS AND RELEVANCE—Most patients with acute stroke exhibited some degree of preventability. Preventability and treatment of stroke were significantly associated, indicating that the most preventable strokes paradoxically were more likely to receive acute treatment.

Neurologic medicine continues to incorporate new approaches to the treatment of acute ischemic stroke,[1] providing additional tools to mitigate brain injury from stroke. Nevertheless, it is generally understood that prevention of stroke remains the optimal approach. To our knowledge, the association between prevention and treatment of stroke has received little attention.

The initial assessment of patients with acute stroke focuses almost entirely on the degree to which the presenting stroke is treatable.[2] While this acute assessment may include attempts to understand the pathophysiologic features of the event, concerns regarding stroke prevention typically take a secondary role in this clinical setting. The primary concerns of treatment typically involve whether intravenous tissue plasminogen activator is indicated and if intra-arterial intervention is appropriate.[3]

The purpose of the current investigation is to address stroke preventability within the perspective of the acute assessment of patients with ischemic stroke. Our objective was to develop a simple, objective scale to assess whether a stroke is preventable. This new instrument would then allow for a formal analysis of the association between stroke preventability and the degree to which the stroke in question can be treated (stroke treatability). Our focus for the preventable stroke was on the medical treatment of widely accepted risk factors for stroke—hypertension,[4] hyperlipidemia,[5] and atrial fibrillation[6]—as well as established cerebrovascular and cardiovascular disease.[7] We hypothesized that preventability and treatability of stroke are related.

Methods

Patients

We evaluated the medical records of patients consecutively discharged with a diagnosis of ischemic stroke from the University of California Irvine Medical Center between December 2, 2010, and June 11, 2012. Patient data were deidentified. Data analysis was conducted from July 3, 2014, to August 4, 2015. Patients were characterized by the presence or absence of treatment of vascular comorbidities; a 10-point scale was created to address the extent of stroke preventability: no preventability (score of 0), low preventability (score of 1–3), and high preventability (score of 4 or higher). The study was approved by the University of California Irvine Institutional Review Board.

Vascular Comorbidities for Preventable Stroke Index

Blood pressure was considered poorly treated if, at the time of stroke presentation, systolic blood pressure was 200 mm Hg or higher (2 points). Blood pressure was considered suboptimally treated if systolic blood pressure at presentation was 180 to 199 mm Hg (1 point). Blood pressure was considered adequately treated if the patient's presenting systolic blood pressure was less than 180 mm Hg (0 points).

Patients with presenting total cholesterol levels of 200 mg/dL or higher (to convert to millimoles per liter, multiply by 0.0259) or low-density lipoprotein cholesterol levels of 150 mg/dL or higher (to convert to millimoles per liter, multiply by 0.0259) were considered to have poorly treated hyperlipidemia (2 points). Patients with presenting total cholesterol levels of 180 to 199 mg/dL or low-density lipoprotein cholesterol levels of 100 to 149 mg/dL were considered to have suboptimally treated hyperlipidemia (1 point). Cholesterol was considered adequately treated if presenting total cholesterol levels were less than 180 mg/dL and low-density lipoprotein cholesterol levels were less than 100 mg/dL (0 points).

Patients with a history of atrial fibrillation or presenting with atrial fibrillation and not receiving anticoagulant medication (owing to interruption in treatment, noncompliance, or medication not prescribed) were considered untreated (4 points). Patients with a history of atrial fibrillation who were taking an anticoagulant and had an international normalized ratio of less than 2 were considered to have suboptimally treated atrial fibrillation (2 points). Patients with a history of atrial fibrillation and an international normalized ratio of 2 or higher, taking a new-generation anticoagulant (not warfarin), not presenting with atrial fibrillation on admission, or having no history of atrial fibrillation were considered to have optimally treated atrial fibrillation (0 points).

Patients with a prior stroke, transient ischemic attack, or myocardial infarction and not taking platelet medications were considered untreated (2 points); patients with a similar history and additional history of atrial fibrillation without therapeutic anticoagulation were also given 2 points. Patients with a history of stroke, transient ischemic attack, or myocardial infarction and taking platelet medications or receiving therapeutic anticoagulation treatment were considered optimally treated (0 points). Patients with no history of stroke, transient ischemic attack, or myocardial infarction were also given 0 points.

Statistical Analysis

Fisher exact tests and χ^2 tests were used to test for independence of qualitative variables. Analysis of variance and *t* tests were used to test for differences in means of continuous variables among groups.

Results

We reviewed the medical records of 274 consecutive patients with stroke at the University of California Irvine Medical Center. Mean (SE) patient age was 67.2 (0.8) years (range, 32–103 years); other patient characteristics are summarized in Table 1. Stroke preventability scores ranged from 0 to 8 (of a possible 10) points. The mean (SE) stroke preventability score was 2.2 (0.1). Two hundred seven patients (75.5%) exhibited some degree of

preventability (score of 1 or higher). Seventy-one patients (25.9%) exhibited high preventability (score of 4 or higher). The breakdown of vascular comorbidities vs preventability is shown in Table 2.

The mean (SE) National Institutes of Health Stroke Scale (NIHSS) score was 9.0 (0.5). The mean NIHSS score did not differ among the stroke preventability groups: the mean score was 9.3 (1.0) among those with no preventability, 8.6 (0.7) among those with low preventability, and 9.5 (1.0) among those with high preventability. Fifty-three patients received interventions for acute stroke with either intravenous or intra-arterial therapy. In contrast with the NIHSS score, the stroke preventability score was significantly related to acute therapy: 13 of 67 patients (19.4%) with no preventability, 19 of 136 patients (14.0%) with low preventability, and 21 of 71 patients (29.6%) with high preventability received such therapy ($P = .03$). There was also a significant association between acute treatment and stroke preventability scores of 0 to 3 (32 of 203 patients [15.8%]) vs 4 or higher (21 of 71 patients [29.6%]) ($P = .01$).

Discussion

In this study, most patients with acute stroke (75.5%) exhibited some degree of stroke preventability, generally consistent with results of a prior study.[8] Our preventability score was not associated with stroke severity as measured by the NIHSS score. However, use of interventions for acute stroke (intravenous and/or intra-arterial therapy) was strongly associated with the preventability score. Patients whose strokes were most preventable were more likely to receive acute stroke interventions.

The findings of our study point to an apparent paradox. The recent breakthroughs in therapy for acute stroke, particularly the effectiveness of intra-arterial thrombectomy, have led to massive efforts to streamline the evaluation of patients with acute stroke and institute therapy as quickly as is feasible.[1–3] These efforts will lead to more effective mitigation of brain injury consequent to acute ischemic stroke. However, our data suggest that the difficulties faced by patients with acute stroke extend far beyond the rather narrow period of emergency stroke treatments. If what could be characterized as a more holistic approach to the problem of stroke is taken, the result is a vast expansion of the window of intervention to include the very stroke prevention efforts that appear to be lacking in so many patients with hyperacute stroke.

Our study has several significant limitations. We defined preventability in retrospective fashion, based on findings at the time of presentation of acute stroke. For example, it is difficult to estimate the effectiveness of hypertension treatment purely on the basis of the presenting blood pressure at the time of acute stroke given that the blood pressure is known to elevate as a consequence of acute stroke.[9] Moreover, our definition of preventability is arbitrary to some extent, we have not included lifestyle factors, and we have not addressed the complexities inherent in patients with coexisting ischemic and hemorrhagic cerebrovascular disease (mixed cerebrovascular disease).[10] However, our focus on physician-dependent treatment factors adds to the ease of determining preventability scores.

We have also emphasized treatment issues related to atrial fibrillation due to the very effective stroke prevention achievable in this population.[6]

Conclusions

Preventability and treatability of stroke are closely associated. This finding emphasizes the enduring importance of stroke prevention in an era of increasingly effective stroke treatment. These findings raise the question of whether resources for treatment of acute stroke are being directed toward patients whose strokes are in fact the most preventable.

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Table 1

Patient Characteristics

Characteristic	Value[a]
Age, mean (SE), y	67.2 (0.8)
Male sex	148 (54.0)
White race	151 (79.1)[b]
Hypertension	206 (75.2)
Dyslipidemia	94 (34.3)
Atrial fibrillation	50 (18.2)
Myocardial infarction	43 (15.7)
Transient ischemic attack	22 (8.0)
Stroke	74 (27.0)
NIHSS score, mean (SE)	9.0 (0.5)[c]

Abbreviation: NIHSS, National Institutes of Health Stroke Scale.

[a] Data are presented as number (percentage) of 274 patients unless otherwise indicated.

[b] Race identified in 191 patients.

[c] NIHSS score determined in 235 patients.

Table 2

Individual Vascular Comorbidities and Preventability Scores[a]

Comorbidity	Preventability, No. (%) of Patients		
	No (Score of 0)	Low (Score of 1–3)	High (Score of ≥4)
Hypertension, score			
0	67 (100)	87 (64.0)	34 (47.9)
1		34 (25.0)	11 (15.5)
2		15 (11.0)	26 (36.6)
Dyslipidemia, score			
0	67 (100)	31 (22.8)	23 (32.4)
1		69 (50.7)	19 (26.8)
2		36 (26.5)	29 (40.8)
Atrial fibrillation, score			
0	67 (100)	129 (94.9)	28 (39.4)
2		7 (5.1)	15 (21.1)
4			28 (39.4)
Vascular history, score			
0	67 (100)	115 (84.6)	46 (64.8)
2		21 (15.4)	25 (35.2)

[a] See the Methods section for the definition of comorbidity scores.