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Dependence in Prestroke Mobility Predicts Adverse Outcomes Among Patients With Acute Ischemic Stroke

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Background and Purpose—Stroke survivors are commonly dependent in activities of daily living; however, the relation between prestroke mobility impairment and poststroke outcomes is poorly understood. The primary objective of this study was to evaluate the association between prestroke mobility impairment and 4 poststroke outcomes. The secondary objective was to evaluate the association between prestroke mobility impairment and a plan for physical therapy.

Methods—This was a secondary analysis of the National Stroke Project data, a retrospective cohort of Medicare beneficiaries who were hospitalized with an acute ischemic stroke (1998 to 2001). Logistic-regression modeling was used to examine the adjusted association between prestroke mobility impairment with patient outcomes and a plan for physical therapy.

Results—Among the 67 445 patients hospitalized with an ischemic stroke, 6% were dependent in prestroke mobility. Prestroke mobility dependence was independently associated with an increased odds of poststroke mobility impairment (odds ratio [OR]=9.9; 95% CI, 9.0 to 10.8); in-hospital mortality (OR=2.4; 95% CI, 2.2 to 2.7); discharge to a skilled nursing facility (OR=3.5; 95% CI, 3.2 to 3.8); and the combination of in-hospital death or discharge to a skilled nursing facility (OR=3.5; 95% CI, 3.3 to 3.8). Prestroke mobility dependence was independently associated with a decreased odds of having a plan for physical therapy (OR=0.79; 95% CI, 0.73 to 0.85).

Conclusions—These data, obtained from a large, geographically diverse cohort from the United States, demonstrate a strong association between dependence in prestroke mobility and adverse outcomes among elderly stroke patients. Clinicians should screen patients for prestroke mobility impairment to identify patients at greatest risk for adverse events. (*Stroke*. 2008;39:2298-2303.)

Key Words: cerebrovascular accident ■ walking ■ elderly ■ outcome assessment

S troke is widely recognized as a major cause of disability among adults and is the most common cause of dependence in activities of daily living (ADLs) among the elderly.[1] Approximately 90% of stroke survivors have permanent neurologic deficits.[2] Two thirds of stroke survivors require rehabilitation,[3] and 50% do not regain their independence.[4,5]

Prestroke disability, including mobility impairment, is more common with older age.[6–17] With the aging of the population, mobility impairment is likely to increase in prevalence in the US population.[18] Although numerous studies[7,9,11,14,19,20] have identified a variety of factors associated with poststroke outcomes (eg, increased age, increased stroke severity), the relation between prestroke mobility and poststroke outcomes has not been established.

This study was designed to examine prestroke disability, specifically mobility impairment, in a large national sample with both ethnic and geographic diversity. We chose mobility impairment, as opposed to a general ADL measure (1 that includes all ADLs such as bathing, dressing, eating, etc) because the ability to ambulate independently is often used as a criterion in determining whether a patient is able to live at home.[6,21–23] The primary objective of the current study was to evaluate the association between prestroke mobility impairment and 4 poststroke outcomes: poststroke mobility, in-hospital mortality, discharge to a skilled nursing facility (SNF), and a combination of in-hospital mortality or discharge to an SNF. The secondary objective was to evaluate the association between prestroke mobility impairment and a plan for physical therapy (PT).

Patients and Methods

Design

This study was a secondary analysis of data from the National Stroke Project (NSP). The NSP is a retrospective cohort of Medicare beneficiaries who were hospitalized in the United States between 1998 and 2001 with a discharge diagnosis of any of the following International Classification of Diseases, 9th revision, Clinical Modification codes: 362.34, transient retinal arterial occlusion; 433.xx, occlusion and stenosis of precerebral arteries; 434.xx, occlusion of cerebral arteries; 435.0, basilar artery syndrome; 435.1, vertebral artery syndrome; 435.3, vertebrobasilar artery syndrome; 435.8, other specified transient cerebral ischemia; 435.9, unspecified transient cerebral ischemia; or 436, acute cerebrovascular disease. The current study focused on data from 67 445 medical records of patients from all 50 states plus the District of Columbia and Puerto Rico who were 65 years of age or older, who were admitted with a diagnosis of ischemic stroke, and for whom the medical record contained documentation about prestroke mobility status.

Variables

The NSP data collection included 170 variables categorized in the following domains: demographics; medications; neurologic symptom deficits in vision, speech, motor, or sensory functioning; medical history; current clinical findings and events; vaccination status; brain imaging; and procedures performed during the hospital stay. We prespecified variables that were available at the time of hospital admission for use in this analysis, including demographics, comorbidity, and stroke severity.

End Points

The primary outcomes were poststroke mobility, in-hospital mortality, discharge to an SNF, and the combined outcome of in-hospital death or discharge to an SNF. The secondary outcome was documentation of a plan for PT after discharge or transfer from the acute-care hospital.

Definitions

The NSP data described patient mobility on a 3-part scale: independent, needs assistance, and dependent. We classified prestroke and poststroke mobility status into 2 groups: patients who could ambulate either with or without the assistance of a person or device were considered "independent" and all other patients were classified as "dependent." We used the dichotomous scale instead of the 3-part ordinal scale for 2 main reasons: the baseline characteristics and the outcomes of the independent and needs assistance groups were similar; and the dichotomized description facilitated the presentation of the research findings.

A plan for rehabilitation was defined as documentation of a plan for therapy after discharge or transfer from the hospital (at an inpatient or outpatient facility). This plan could include PT, occupational therapy, speech therapy, neuropsychological therapy, or other inpatient rehabilitation.

Stroke severity was defined by summing the number of domains (vision, speech, motor, or sensation) in which a neurologic deficit was present at the time of hospital admission. The stroke severity score ranged from 0 (no deficits remaining at the time of admission to the hospital) to 4 (a deficit present in each of the 4 domains). A modified Charlson comorbidity index was created on the basis of the number of comorbid conditions documented at the time of admission.[24] Patients were categorized into 3 categories based on the number of their comorbid conditions: 0, 1, or 2 or more conditions.

Data Analysis

All analyses were conducted with the software program PC-SAS 8.0 (SAS Institute, Cary, NC). The associations between prestroke mobility and the study end points were evaluated as follows. χ^2 analysis (step 1) was used to identify variables other than prestroke mobility status (eg, stroke severity) associated with the study end points based on a probability value <0.05. To identify the variables

that were independently associated with the study end points, all of the variables identified in step 1 were entered into a logistic-regression model with backward selection. Each model included the variables identified in step 1, with separate models for each of the study end points (step 2). After adjusting for the factors identified in step 2, the adjusted odds ratio (OR) between dependence in prestroke mobility and each of the end points was examined by full regression modeling. Again, separate models were built for each end point (step 3).

No imputations were made for missing data. There were no missing data for prestroke mobility status because the cohort was assembled on the basis of known values for age and prestroke mobility status. There were no missing data for the 5 outcomes. For some of the covariates, the NSP scale contained an "unable to determine" value. In most cases, this value was categorized with the "no" or "not present" value. For example, the NSP classified whether a speech deficit was present at the time of admission in 3 categories: "yes," "no," or "unable to determine." For the purpose of the present study, we categorized a speech deficit as either "present" (includes the "yes" values only) or "not present or undetermined" (includes both "no" and "unable to determine" values). This recategorization involved few patients ($<1\%$ of medical records) with 2 exceptions: prearrival setting (in 2.75% of medical records) and discharge setting (in 2.4% of medical records).

A Bonferroni adjustment was used to protect against a type I error in the bivariate analysis. The Bonferroni adjustment was calculated on the basis of 5 prespecified outcomes ($0.05/5=0.01$). Therefore, $P<0.01$ was used to define statistical significance. An event-per-variable ratio of at least 20:1 was maintained for all multivariable models.[25,26]

Results

Among the 67 445 patients in this cohort, 3938 (5.8%) were dependent in prestroke mobility. When comparing patients who were dependent in prestroke mobility with patients who were independent, the dependent patients were more likely to be older (median, 81 vs 78 years), of black race/ethnicity (14% vs 7%), female (67% vs 56%), to have been admitted from an SNF (36% vs 5%), and to have multiple comorbidities (92% vs 84%; see Table 1).

Poststroke Mobility

A total of 18 232 (28.7%) patients were dependent in poststroke mobility. Five factors were independently associated with dependent poststroke mobility: increasing age, female sex, black race/ethnicity, increasing stroke severity, and increasing comorbidities. Two factors, a plan for rehabilitation and prehospital residence at home, were independently associated with a decreased chance of dependent mobility after stroke. After adjusting for all of the factors associated with poststroke mobility, prestroke mobility impairment was associated with markedly increased odds of poststroke mobility impairment (adjusted OR=9.9; 95% CI, 9.0 to 10.8; see Table 2).

In-Hospital Mortality

The overall in-hospital mortality rate for this cohort was 4.7% (3152/67 445). Three factors were independently associated with in-hospital death: increasing age, increasing stroke severity, and increasing comorbidities. One factor, prehospital residence at home, was independently associated with a decreased chance of in-hospital death. The OR between prestroke mobility impairment and in-hospital death was examined after adjusting for the other factors associated with in-hospital mortality, and prestroke mobility impairment was

Table 1. Baseline Characteristics

Characteristic	Whole Cohort N=67 445	%	Prestroke Mobility Status Independent n=63 507	%	Dependent n=3938	%	P Value*
Age (years)							
Range	65–94		65–94		65–94		
Mean±SD	78.0±7.2		77.9±7.1		80.9±7.3		<0.001
Median	78.0		78.0		81.0		
Race							
White	52 856	78.4	50 000	78.7	2856	72.5	<0.0001
Black	4959	7.4	4420	7.0	539	13.7	<0.0001
Hispanic	1828	2.7	1683	2.7	145	3.7	0.0001
Other	7802	11.6	7404	11.7	398	10.1	0.0031
Gender							<0.0001
Female	38 156	56.6	35 518	55.9	2638	67.0	
Male	29 282	43.4	27 982	44.1	1300	33.0	
Prestroke residence							<0.0001
Home	52 294	77.5	50 356	79.3	1938	49.2	
SNF	4408	6.5	3219	5.1	1419	36.1	
Rehabilitation hospital	322	0.5	261	0.4	61	1.5	
Other	10 421	15.4	9671	15.2	520	13.2	
Past neurologic history							
TIA ≤6 mo	2882	4.3	2781	4.4	101	2.6	<0.0001
TIA >6 mo	9592	14.2	9059	14.3	533	13.5	0.2033
Stroke	31 100	46.1	28 314	44.6	2786	70.7	<0.0001
Stroke severity							<0.0001
0 deficits	28 890	42.8	27 539	43.4	1351	34.3	
1 deficit	20 132	29.9	18 753	29.5	1379	35.0	
≥2 deficits	18 423	27.3	17 215	27.1	1208	30.7	
Comorbidity index							<0.0001
0	2340	3.5	2252	3.5	88	2.2	
1	8244	12.2	7998	12.6	246	6.2	
≥2	56 861	84.3	53 257	83.9	3604	91.5	
Poststroke residence							<0.0001
Home	38 908	57.7	37 857	97.3	1051	2.7	
SNF	12 911	19.1	11 091	85.9	1820	14.1	
Rehabilitation hospital	7678	11.4	7194	93.7	484	6.3	
Other	4796	7.1	4494	93.7	302	6.3	

TIA indicates transient ischemic attack; SD, standard deviation.

*The P values, obtained from t tests for dimensional variables and χ^2 tests for categorical variables, pertain to the comparison between patients who are independent vs dependent in prestroke mobility.

associated with increased odds of in-hospital mortality (adjusted OR=2.4; 95% CI, 2.2 to 2.7; see Table 2).

Discharge to an SNF

The majority of patients in this cohort were discharged to home (57.7%, or 38 908/67 445) after their stroke hospitalization, with 19.1% (12 911) being discharged to an SNF, 11.4% (7678) to a rehabilitation hospital, and 7.1% (4796) to another discharge location. Four factors were independently associated with discharge to an SNF: increasing age, female sex, increasing stroke severity, and increasing comorbidities.

Two factors, no plan for rehabilitation and prehospital residence at home, were independently associated with a decreased chance of discharge to an SNF. In the fully adjusted multivariable model, prestroke mobility impairment was associated with increased odds of discharge to an SNF (adjusted OR=3.5; 95% CI, 3.2 to 3.8; see Table 2).

In-Hospital Death or Discharge to an SNF

In-hospital death or discharge to an SNF was used as a combined end point because this combination is often used as an outcome in studies of stroke patients, because such

Table 2. Adjusted ORs by Outcomes

Characteristic	Adjusted OR (95% CI)				
	Poststroke Mobility Impairment	Plan for PT	In-Hospital Death	Discharge to SNF	In-Hospital Death or Discharge to SNF
Prestroke mobility					
Independent	1.00	1.00	1.00	1.00	1.00
Dependent	9.88 (9.03–10.80)	0.79 (0.73–0.85)	2.40 (2.15–2.67)	3.51 (3.25–3.79)	3.52 (3.27–3.79)
Age=65–74 y	1.00	1.00	1.00	1.00	1.00
75–84 y	1.33 (1.27–1.39)	1.39 (1.34–1.45)	1.53 (1.39–1.68)	2.07 (1.96–2.19)	2.10 (2.00–2.20)
85–94 y	1.88 (1.78–1.97)	1.71 (1.63–1.79)	2.24 (2.02–2.48)	4.34 (4.08–4.61)	4.54 (4.30–4.79)
Race, black	1.38 (1.29–1.48)	1.40 (1.32–1.50)	…	…	1.08 (1.01–1.17)
Sex, female	1.14 (1.10–1.19)	1.14 (1.10–1.18)	…	1.34 (1.28–1.40)	1.31 (1.26–1.37)
Admission from home	0.69 (0.66–0.72)	0.96 (0.92–1.00)	0.70 (0.65–0.76)	0.30 (0.29–0.31)	0.33 (0.32–0.34)
Stroke severity=0	1.00	1.00	1.00	1.00	1.00
1	1.12 (1.07–1.17)	3.44 (3.30–3.58)	1.75 (1.59–1.94)	1.45 (1.38–1.53)	1.90 (1.81–1.99)
≥2	1.44 (1.38–1.51)	4.71 (4.51–4.91)	3.05 (2.78–3.35)	1.81 (1.72–1.91)	2.73 (2.60–2.86)
Comorbidity=0	1.00	1.00	1.00	1.00	1.00
1	1.11 (0.98–1.26)	1.16 (1.03–1.30)	0.93 (0.72–1.21)	1.00 (0.86–1.15)	0.99 (0.87–1.13)
≥2	1.61 (1.43–1.80)	1.66 (1.50–1.84)	1.25 (0.99–1.57)	1.27 (1.11–1.45)	1.43 (1.27–1.62)
Plan for PT=no	1.79 (1.72–1.86)	…	…	0.33 (0.31–0.34)	…

outcomes are considered the worst.[27] A total of 16 063 patients in this cohort died in the hospital or were discharged to an SNF (23.8%). Five factors were independently associated with in-hospital death or discharge to an SNF: increasing age, female sex, black race/ethnicity, increasing stroke severity, and increasing comorbidities. One factor, prehospital residence at home, was independently associated with a decreased chance of in-hospital death or discharge to an SNF. In the fully adjusted multivariable model, prestroke mobility impairment was associated with increased odds of in-hospital death or discharge to an SNF (adjusted OR=3.5; 95% CI, 3.3 to 3.8; see Table 2).

Plan for PT Services

In this cohort, 24 548 stroke patients (36.4%) had a plan for PT services. Six factors were independently associated with a plan for PT services: increasing age, female sex, black race/ethnicity, increasing stroke severity, increasing comorbidity index, and impaired poststroke mobility. One factor, prestroke residence at home, was independently associated with a decreased likelihood of a plan for PT services. Prestroke mobility impairment was associated with decreased odds of having a plan for PT services after adjustment for all of the factors associated with a plan for PT services (adjusted OR=0.8; 95% CI, 0.7 to 0.9; see Table 2).

Summary of Multivariable Results

As described, several factors were independently associated with the 5 outcomes. Specifically, age, black race/ethnicity, female sex, prestroke residence at home, increasing stroke severity, and increasing comorbidity were factors that were often strongly associated with the 5 outcomes (see Table 2). Therefore, the association between prestroke mobility and the 5 outcomes must be evaluated in the context of these other known associations. Across the 5 multivariable models, the

adjusted OR for prestroke mobility varied, but in all cases prestroke mobility impairment was independently associated with outcome. The association between prestroke mobility impairment and a particular outcome might not be as strong as the association between other factors and that same outcome. Although these associations may be of interest in a future study, they were not the focus of the current study.

Discussion

This study of prestroke mobility and outcomes for patients hospitalized with an ischemic stroke was based on a large, nationally representative sample. The results demonstrate that although prestroke mobility impairment is uncommon, prestroke mobility impairment is prognostically important among elderly stroke patients.

Specifically, this study found that prestroke mobility impairment was associated with both discharge to an SNF and in-hospital death. Patients with prestroke mobility impairment had a >3-fold increase in the odds of discharge to an SNF and more than doubled odds of in-hospital mortality, even after adjusting for the factors associated with these outcomes. As expected, the results also indicate that prestroke mobility impairment was strongly associated with poststroke mobility impairment. Other studies have similarly found that impaired prestroke physical function (not specifically mobility) was associated with poststroke disability,[3,28–30] greater mortality,[3,31,32] and institutionalization.[28,31,32]

The finding that prestroke mobility impairment was associated with adverse poststroke outcomes is clinically relevant and worthy of future investigation. Several hypotheses may be articulated regarding the role of prestroke mobility impairment in contributing to adverse events. Prestroke mobility impairment may lead to an adverse event by the following potential mechanisms: (1) decreased ambulation, leading to prolonged bed rest, which in turn leads to deep vein throm-

boses, atelectasis, or decubitus ulcers; (2) decreased participation in rehabilitation and recovery programs, leading to deconditioning of unaffected motor groups and/or decreased functional gains in affected areas; and (3) increased falls. Future studies should evaluate these hypotheses to elucidate the mechanisms by which prestroke mobility impairments impair recovery. Future studies should also evaluate interventions to reduce the burden of prestroke mobility impairment. For example, if bed rest is a mechanism by which prestroke mobility impairment leads to adverse events, then perhaps interventions to reduce bed rest, such as restorative nursing ambulation and exercise programs, might improve outcomes in patients with prestroke mobility impairment.

This study also demonstrated that the patients with prestroke mobility impairment (those at high risk of poststroke adverse events) were unlikely to have a plan for rehabilitation services, even after adjustment for stroke severity and the other factors related to rehabilitation service planning. Whereas previous studies have focused on the receipt of PT services through the continuum of stroke care or the association of receipt of services with patient outcomes,[33–36] we are unaware of published data regarding the association between prestroke mobility impairment and PT service planning. Future studies should investigate reasons why patients with prestroke mobility impairment are less likely to receive PT services.

One hypothesis regarding the association between prestroke mobility dependency and both adverse outcomes and decreased PT service planning is that patients with prestroke mobility dependence may be more likely to reside in a nursing home than patients who can ambulate independently. If nursing home residence is a marker of increasing comorbidity and frailty, then prestroke mobility impairment may simply be a surrogate for increasing comorbidity and frailty. The NSP data provide some insight into this hypothesis. As expected, patients who were dependent in prestroke mobility were less likely to have a prestroke residence at home and more likely to have high comorbidity than patients who were independent in prestroke mobility. (The NSP data did not contain a measure of patient frailty.) Also as expected, prehospital residence at home was associated with a reduced odds of adverse events (both in-hospital death and discharge to an SNF). Unexpectedly, prehospital residence at home decreased the odds of a plan for PT. Given that the association between prestroke mobility impairment and adverse outcomes persisted after adjustment for prestroke residence and comorbidity, it is unlikely that prestroke residence or comorbidity fully explain the association between prestroke mobility and outcomes.

Limitations

Several limitations of these data require discussion. First, the data collection did not include a complete assessment of the patients' prestroke functional status. Given that disability in 1 domain may be associated with impairments in other functional domains, prestroke mobility impairment may be a marker of disability in other activities of daily living. Second, the NSP data did not describe what assistive devices the patient may have used, if the patient required bracing, or how much assistance from a helper was required for ambulation. No information was available regarding what distance a patient was capable of walking or if the patient was at risk for falls. Third, the plan for PT services did not describe what type of service the patient actually received but simply referred to whether a plan for PT was documented. Fourth, the NSP did not include a formal metric of stroke severity. We used the data about stroke symptoms to create a stroke severity measure for use in this study. As described earlier, we categorized deficits as either "present" or "not present or undetermined" on the basis of the medical record data. This may have underestimated stroke severity. Although our stroke severity measure operated in general as expected, it has not been validated. Last, the population included in this study consisted of stroke patients 65 years of age and older with Medicare insurance. Although nearly three quarters of all strokes in the United States occur in such patients, the results from this study may not be generalizable to younger patients or those without medical insurance.

Conclusions

Given the strong association between prestroke mobility impairment and poor outcomes after stroke, screening for prestroke mobility impairments may identify a group of stroke patients at high risk of adverse events. Screening for prestroke mobility impairment does not require specialized structures of care; therefore, it is a process of care that can be implemented across the full spectrum of medical centers. We recommend that clinicians ask patients and their caregivers about prestroke mobility at the time of hospital admission. Researchers should evaluate the efficacy of interventions to reduce the burden of prestroke mobility dependence and its effect on adverse outcomes.

Disclosures

None.

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American Heart Association

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