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Relationship Between Diabetes Codes That Affect Medicare Reimbursement (Tier Comorbidities) and Outcomes in Stroke Rehabilitation

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Abstract

Objectives—To examine the extent to which diabetes codes that increase reimbursement (tier comorbidities) under the prospective payment system are related to length of stay and functional outcomes in stroke rehabilitation.

Design—Secondary data analysis.

Setting—Inpatient rehabilitation facilities (N=864) across the United States.

Participants—Patients (N=135,097) who received medical rehabilitation for stroke in 2002–2003.

Intervention—None.

Main Outcome Measures—Length of stay, FIM instrument, and discharge setting. Diabetes status was assigned to 1 of 3 categories: tier (increases reimbursement), nontier (no reimbursement effect), and no diabetes.

Results—Mean $\pm$ standard deviation age of the sample was 70.4 ± 13.4 years, and 31% had diabetes (6% tier, 25% nontier). Diabetes status by age demonstrated significant ($P < .05$) interaction effects, which lead to the following age-specific findings. In younger stroke patients (60y), tier diabetes was associated with shorter lengths of stay compared with both groups, lower FIM discharge scores compared with both groups, and lower odds of discharge home relative to the no-diabetes group. In older stroke patients (80y), tier diabetes was associated with longer lengths of stay compared with both groups and with higher FIM discharge scores compared with the nontier group.

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Supplier

a. SPSS version 14.0; SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.

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Conclusions—The diabetes-related conditions identified as tier comorbidities under the prospective payment system are significant predictors of stroke rehabilitation outcomes, but these relationships are moderated by patient age.

Keywords

Diabetes mellitus; Prospective payment system; Rehabilitation; Stroke

Stroke is the most frequent cause of disability and ranks third for mortality among adults in the United States.¹ Because the prevalence of stroke increases with age,^{1,2} the immediate and often permanent neurologic impairments resulting from stroke tend to occur in older people with existing chronic conditions.³ These comorbid conditions can compound disability, inhibit functional restoration, and increase medical costs.^{4,5} Because Medicare payments for inpatient rehabilitation are determined prospectively, it is imperative to ascertain how certain combinations of health conditions can affect rehabilitation needs and recovery trajectories.

The IRF-PPS was introduced in 2002. Reimbursement rates under the IRF-PPS are based on projected resource use (costs) for a given patient. Each patient is assigned to a case-mix group at admission to rehabilitation. Patient-level information from the IRF-PAI⁶ is used to determine the case-mix group and includes the patient's primary impairment or medical condition, functional status, and age. The payment categories for each case-mix group are further stratified into tiers on the basis of the presence of specific comorbidities that have been shown to increase costs.⁷ Currently, payment adjustments for comorbidities consist of a 4-tier system: tier 1 (high cost), tier 2 (medium cost), tier 3 (low cost), and no tier.⁸

Diabetes mellitus is a risk factor for stroke,^{1,9–11} and diabetes-related complications can slow recovery and limit restoration of physical functioning.^{12–14} The prevalence of diabetes in the U.S. population increased more than 4-fold over the last half of the 20th century.¹² Because of the independent disabling effects of diabetes^{10,15,16} and the frequent co-occurrence of diabetes and stroke, the influence of diabetes on stroke outcomes is well represented in the health care literature.^{14,17–24} It is well established, for example, that diabetes is associated with stroke at younger ages^{18,21} and with lower incidence of hemorrhagic stroke.^{18,20,25} Both age^{17,19,22,24–27} and stroke type^{23,26,28} are known to affect the rate and extent of functional recovery.

The purpose of this study was to examine the effect of diabetes on rehabilitation length of stay and outcomes after stroke. More specifically, we were interested in assessing the effects of tier-eligible diabetes comorbidities on rehabilitation length of stay and functional outcomes after stroke and in evaluating whether these effects are moderated by patient age or stroke type. To our knowledge, no prior investigation has evaluated the subset of diabetes-related conditions that are specific indicators of increased resource use and additional reimbursement under the IRF-PPS. Nor have the interaction effects of diabetes status and age or diabetes status and stroke type been reported for stroke rehabilitation outcomes.

METHODS

Data Source

We obtained data from 864 rehabilitation hospitals and units across the U.S. that submit data to the UD_{SMR} inpatient rehabilitation facility registry. The UD_{SMR} database is the largest nongovernment registry for standardized medical rehabilitation information in the U.S.^{29,30} The database contains the same patient- and facility-level data that are submitted to the Centers for Medicare and Medicaid Services as part of the IRF-PPS. Relevant data for this study include patient sociodemographic characteristics; the primary impairment, an etiologic diagnosis, and

up to 10 comorbid diagnoses on the basis of the ICD-9 codes; length of stay; discharge setting; and standardized measures of functional status at both admission and discharge.

Study Sample

Patient records for this study were limited to those receiving inpatient rehabilitation services with a primary diagnosis of stroke and discharged in the first 2 years after introduction of the IRF-PPS: 2002 and 2003. Stroke etiology included ICD-9 codes 430 through 434.9, 436, and 438.0 through 438.9. The initial sample meeting these criteria contained 158,199 patient records. Patients were excluded if the stroke occurred more than 1 year previously (n=4936); if this was not their initial rehabilitation admission (n=8866); if they were not living at home before stroke onset (n=5425); if they experienced a program interruption wherein they were temporarily transferred to an acute unit before returning to rehabilitation (n=1261); or if they experienced atypical lengths of stay, less than 3 days or more than 100 days (n=2614). The final sample included 135,097 patients, which represents 85% of the original sample.

Independent Variable

Diabetes status—Each patient record contains as many as 10 comorbid conditions. Patients were identified as having diabetes if one or more of the following diabetes ICD-9 codes were reported: 250.0 through 250.9 (diabetes mellitus), 357.2 (polyneuropathy in diabetes), or 785.4 (gangrene). Patients with diabetes were further subdivided on the basis of whether their diabetes code was one of the tiered comorbidities under the IRF-PPS⁶ (table 1). Each patient's diabetes status was coded as no diabetes, nontier diabetes, or tier diabetes. For entry into the regression models, this 3-level variable was dummy coded (0, 1), with tier diabetes serving as the reference category.

Dependent Variables

Primary dependent variables of interest were rehabilitation length of stay, FIM discharge, and proportion discharged home.

Length of stay—Rehabilitation length of stay is the total number of days spent in the medical rehabilitation unit or hospital. For patients who are temporarily transferred to an acute-care hospital and returned to rehabilitation within 3 days, the days spent in acute care were not included in the length-of-stay variable.

Discharge FIM—Functional status was evaluated by using items from the FIM instrument, which is part of the IRF-PAI.⁶ The FIM instrument is administered within 3 days of admission to and 3 days of discharge from inpatient rehabilitation. The FIM instrument includes 18 items that assess patient abilities across 6 subscales: self-care, sphincter control, transfers, mobility, communication, and social cognition. Scores for each item range from 1 (total assistance) to 7 (complete independence). The reliability and validity of the FIM data have previously been substantiated.^{31,32} FIM total represents the summation of all 18 items (range, 18–126 items). Stineman et al³³ used multitrait scaling analyses to evaluate the psychometric properties of FIM items and determined that the unweighted summed scores (motor, cognitive, and/or total) are appropriate outcome measures.

Discharge setting—The UDS_{MR} database contains information on the type of discharge setting, including home, transitional living, assisted living, intermediate care, skilled nursing facility, long-term care facility, other rehabilitation facility, and acute care. For the current analysis, discharge setting was dichotomized as home versus not home.

Covariates

Sociodemographic variables included age (years), sex, race/ethnicity (black, Hispanic, white, other; recoded as white vs nonwhite for entry in regression models), and marital status (married vs not married). Medical factors included stroke type (nonhemorrhagic vs hemorrhagic); the sum of other, nondiabetes, comorbidities (range, 0–10); and duration from stroke onset to rehabilitation admission (days).

Statistical Analysis

Patient characteristics and outcomes were first stratified by diabetes status and examined through univariate descriptive statistics. One-way analysis of variance with post-hoc tests and chi-square tests were used to assess univariate differences among continuous and categorical variables, respectively. Multiple linear regressions were used to predict the effects of diabetes status on rehabilitation length of stay and FIM discharge. Logistic regression was used to estimate the likelihood of discharge home on the basis of diabetes status.

As a result of the acknowledged association between diabetes and both age at onset and type of stroke, as well as the recognized influence of age and stroke type on rehabilitation outcomes, interaction variables linking diabetes by age and diabetes by stroke type were assessed for significance in all 3 prediction models. The interaction variables were created by dummy coding the 3-level diabetes variable (reference category is tier diabetes) and then multiplying by the values of the age (continuous) and stroke type (dichotomous) variables. The diabetes by age interaction was significantly ($P < .05$) related to all 3 outcomes. The diabetes by stroke type interaction term was not significantly ($P < .05$) related to any of the outcomes, so it was not included in any of the 3 prediction models.

Diabetes status and all covariates were entered as single blocks in each of the linear and logistic regression models. All 3 prediction models controlled for patient age, sex, race/ethnicity, sum of nondiabetes comorbidities, stroke type, and the diabetes by age interaction term. In addition, the linear regression models included FIM admission and duration from onset to rehabilitation admission and the logistic regression model included FIM discharge and marital status. To facilitate interpretation of the significant diabetes by age interaction terms, we estimated the effect of diabetes status on outcomes at 3 consecutive 10-year age intervals: 60 years, 70 years, and 80 years of age. These ages were chosen to maximize practical application of the results by including mean age (70y) and 10 years younger and older. SPSS (v14.0) software^a was used for all statistical tests.

RESULTS

The prevalence of diabetes in this sample of patients receiving inpatient rehabilitation services after an acute stroke was 31.2%. Table 2 displays patient characteristics and rehabilitation outcomes stratified by diabetes status along with the P values obtained through the univariate analyses to reveal unadjusted between-group differences.

Table 3 presents the unstandardized regression coefficients (b) or odds ratios and 95% confidence intervals for the diabetes categories and all covariates relating to each of the 3 outcome measures. The tier diabetes effect appears strong in all 3 adjusted models; however, the interaction with age prohibits the interpretation of these main effects across the entire sample.

Figures 1 through 3 show estimated values for all 3 outcomes, respectively, within the range of patient ages while controlling for all other covariates in the models displayed in table 2. Overall, the data show parallel declines (similar slopes) in outcome values for the nontier and no-diabetes groups with increasing age. Alternatively, the tier group begins at lower values on

all 3 outcomes and exhibits less decline with increasing age compared with the other 2 groups. Predicted values and tests of significance are included for 3 age cohorts: 60, 70, and 80 years.

DISCUSSION

The principal goal of medical rehabilitation is to maximize functioning and restore independence. This study examined the effect of diabetes on rehabilitation length of stay and outcomes in patients after an acute stroke. The results show that tier diabetes was significantly related to length of stay, functional status, and discharge home. Although the main effects of tier diabetes appear substantial among all 3 outcomes (see table 3), the significant diabetes by age interactions preclude acceptance and interpretation of these main effect values. Subsequently, group-specific relationships between age and all 3 outcomes as well as intergroup comparisons at specified ages are shown in figures 1 through 3.

Previous research suggests that diabetes leads to stroke at younger ages^{18,21} and relatively fewer hemorrhagic strokes.^{18,20,25} Our sample upholds these conclusions. Table 2 shows that the tier diabetes group was significantly younger and experienced less hemorrhagic stroke than the other 2 groups. The literature describing the effect of age on functional performance is consistent; age is significantly and inversely related to functioning and functional recovery after stroke.^{17,19,22,24–27} And although data describing the relationship between stroke type and functional status at admission are mixed,^{23,26} there is apparent consensus regarding the fact that hemorrhagic stroke is associated with greater functional improvements during inpatient rehabilitation compared with ischemic stroke.^{23,26,28} In the current analyses, age demonstrated a significant interaction with diabetes status for all 3 outcomes, whereas the diabetes and stroke type interaction term did not reach significance for any outcome. These findings suggest that the effect of diabetes on stroke rehabilitation outcomes is more pronounced at certain ages compared with others, and that diabetes status does not affect outcomes differently in those with hemorrhagic stroke versus those with other causes of stroke.

Tier status is designed to account for additional resource use (treatment costs) under the Medicare IRF-PPS.⁸ Although length of stay does not reflect the intensity or specialization of services rendered, an earlier review concludes that neither greater intensity of services nor the use of specialized therapies demonstrates strong relationships with functional improvement in stroke rehabilitation.³⁴ Length of stay was used as a proxy for cost in the current study because it is the primary determinant of stroke care costs.^{35,36} Previous studies that used the standard dichotomous (yes/no) coding for diabetes and only testing for the main effect of age have consistently reported no significant differences in lengths of stay.^{18,21,22} Our results are interesting because compared with the other 2 groups, tier diabetes was associated with slightly shorter lengths of stay in younger patients (average of 0.4d at 60y of age) and slightly longer lengths of stay in older patients (average of 0.3d at 80y of age) (see fig 1). It is important to reiterate that the IRF-PPS and corresponding tier system are Medicare-based policies and that relatively longer lengths of stay observed in the tier diabetes group continued to increase with advancing age. In addition, although the actual differences in lengths of stay appear to hold little clinical importance at the individual patient level, this may not be the case at the institutional and national levels. From the facility and payer perspectives, an outcome such as length of stay needs to be evaluated in the context of cumulative effects over several patients. The mean 0.3-day differential that we found between tier diabetes and the other 2 groups, for example, would result in 3 additional days of rehabilitative care for 10 patients with tier diabetes. When this scenario is applied to thousands of patients, the cumulative effects could lead to substantial increases in costs, staffing needs, and so on for a given facility over time.

Figure 3 shows an overall pattern of decreasing discharge home with increasing age across all 3 diabetes groups. Small yet statistically significant differences were observed between the tier

and no-diabetes groups at 60 years of age; however, comparisons at older ages (70y and 80y) yielded no significant differences in likelihood of discharge home, which is in agreement with previous studies.^{22,23} Thus, it appears that diabetes status does not have a robust effect on discharge status after stroke rehabilitation and that any modest association is trumped by the marked relationship between age and discharge setting.

Similar to both length of stay and likelihood of discharge home, the influence of tier diabetes on postrehabilitation functional status (FIM discharge) was most pronounced in the younger-age (60y old) cohort (see fig 2). The adjusted mean tier-group discharge FIM score was 1.0 and 2.3 points lower than the nontier and no-diabetes groups, respectively, at 60 years of age. The magnitude of these differences diminishes with age such that by 80 years of age, the tier group was within 0.5 points of both groups. Thus, tier diabetes status appears to have little if any effect on discharge functional status in older patients with stroke. Four prior studies reported no significant diabetes-related difference in either discharge functional status or functional change from admission to discharge in stroke rehabilitation; 3 of these studies used the FIM instrument,^{21–23} and the other used the Barthel Index.¹⁸ All 4 are single-facility studies with smaller sample sizes compared with the large national sample used in the current study, and none evaluated the interaction between diabetes status and age.

In general, the existing literature indicates no relationship between diabetes and stroke rehabilitation outcomes. One explanation for this may be related to the standard dichotomous (yes/no) coding of diabetes status in the stroke rehabilitation literature. The diagnosis of diabetes represents a heterogeneous group of patients who are at various points along a continuum of disease duration and severity and who have 1 or more diabetes-related complications. Thus, the degree of functional impairment and inhibition of recovery after stroke is quite variable within the global designation of diabetes. Differentiating tier-related diabetes allowed us to examine a relatively homogeneous subset of patients with more severe and uncontrolled diabetes-related complications, which corresponds to the greater allotment for these cases under the IRF-PPS. And although the observed differences in adjusted values are of only limited clinical importance, significant differences through both multivariate (see table 3) and univariate (see table 2) analyses were observed between tier diabetes and no diabetes, and between tier and nontier diabetes.

Study Limitations

This study has several limitations. First, we lacked data on many factors preceding admission to rehabilitation, including prior disability status and information regarding the acute-care hospitalization experience. We controlled for functional status at admission, comorbidity burden, and the time from onset of stroke to rehabilitation admission to account for potential confounding effects. We excluded people not living at home before the stroke. Second, information in the UDS_{MR} database is obtained through medical records and observation, so coding and reporting errors can occur. Last, we used ICD-9 codes from patient records to categorize our primary independent variable (tier diabetes, nontier diabetes, no diabetes), and it has been suggested that reliance on these codes may lead to underreporting of severity or intensity of complications.³⁷ This is more likely to occur with the nontiered diabetes codes. Given the financial incentives and standardized procedures in the prospective payment environment, however, it is doubtful that tier-eligible codes are systematically underreported.

A strength of this study is the use of a large national sample, which provides a powerful and generalizable assessment of the effect of diabetes on stroke rehabilitation outcomes. To our knowledge, this is the first study to differentiate tier and nontier categories when evaluating relationships between diabetes and stroke rehabilitation outcomes. In addition, our analysis demonstrates the importance of evaluating the interactive effect of age on the relationship between diabetes and stroke rehabilitation outcomes.

CONCLUSION

Chronic health conditions increase with age. These cumulative impairments and physiologic interactions can impede recovery during medical rehabilitation stays. Stroke is a common impairment category in inpatient rehabilitation, and diabetes is a frequent comorbidity for stroke. The comorbidity tier structure within the IRF-PPS is designed to account for specific conditions that are likely to inhibit recovery and increase resource use. The current results show that diabetes-related conditions that are identified as tier comorbidities under the IRF-PPS have statistically significant effects on stroke rehabilitation outcomes and that these effects are moderated by patient age. Additional study is needed to assess differences in specific rehabilitation needs and total resource use among stroke patients in the tier, nontier, and no-diabetes categories.

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List of Abbreviations

ICD-9	International Classification of Disease, 9th edition
IRF-PAI	Inpatient Rehabilitation Facility—Patient Assessment Instrument
IRF-PPS	Inpatient Rehabilitation Facility—Prospective Payment System
UDS_{MR}	Uniform Data System for Medical Rehabilitation

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Fig 1.

Predicted values for length of stay by age for all 3 diabetes groups controlling for all other variables listed in the model in table 3. ‡Significant ($P < .05$) difference between tier diabetes and no-diabetes groups. †Significant ($P < .05$) difference between tier diabetes and nontier diabetes groups.

Fig 2.

Predicted values for discharge FIM total by age for all 3 diabetes groups controlling for all other variables listed in the model in table 3. ‡Significant ($P < .05$) difference between tier diabetes and no-diabetes groups. †Significant ($P < .05$) difference between tier diabetes and nontier diabetes groups.

Fig 3. Predicted percentage of discharges home by age for all 3 diabetes groups controlling for all other variables listed in the model in table 3. ‡Significant ($P < .05$) difference between tier diabetes and no-diabetes groups.

Table 1

Descriptions of Nontier and Tier Eligible Comorbidity Codes

ICD-9 Categories	Description	Tier Eligible
250.0	Diabetes mellitus without mention of complication	No
250.1	Diabetes with ketoacidosis	No
250.2	Diabetes with hyperosmolarity	No
250.3	Diabetes with other coma	No
250.4	Diabetes with renal manifestations	Yes
250.5	Diabetes with ophthalmic manifestations	Yes
250.6	Diabetes with neurological manifestations	Yes
250.7	Diabetes with peripheral circulatory disorders	Yes
250.8	Diabetes with other specified manifestations	Yes
250.9	Diabetes with unspecified complication	Yes
357.2	Polyneuropathy in diabetes	Yes
785.4	Gangrene	Yes

NOTE. All tier-eligible diabetes codes are classified as tier 3 under the prospective payment system.

Table 2
Patient Characteristics and Outcomes for Stroke Rehabilitation Stratified by Diabetes Status

Characteristics	Total	Tier (1)	Nontier (2)	No Diabetes (3)	P		
					1 vs 2	1 vs 3	2 vs 3
N	135,097	8,158	34,080	92,859			
Age (y)	70.41±13.43	68.83±11.58	69.57±11.74	70.86±14.12	.000	.000	.000
Women (%)	52.9	50.1	51.0	53.8	.144	.000	.000
Ethnicity					.000	.000	.000
White (%)	74.9	70.7	66.4	78.4			
Black (%)	15.6	18.1	21.1	13.4			
Hispanic (%)	5.0	6.6	7.5	4.0			
Other (%)	4.4	4.5	5.1	4.2			
Married (%)	51.4	53.4	53.2	50.6	.729	.000	.000
Comorbidities, sum	6.58±2.77	7.17±2.10	6.44±2.36	6.58±2.95	.000	.000	.000
Stroke type					.000	.000	.000
Other (%)	37.8	40.6	40.7	36.6			
Hemorrhagic (%)	14.6	7.2	10.1	17.0			
Ischemic (%)	47.5	52.2	49.3	46.5			
Onset to admission (d)	11.55±21.46	11.19±22.40	11.32±21.75	11.67±21.27	.623	.052	.010
FIM admission	59.01±19.94	59.64±18.88	59.08±19.42	58.93±20.21	.021	.002	.258
FIM discharge	82.70±23.82	82.27±22.94	82.03±23.66	82.98±23.95	.404	.010	.000
FIM gain	23.68±14.75	22.63±14.66	22.95±14.36	24.05±14.88	.078	.000	.000
Length of stay (d)	17.90±10.32	17.82±9.54	17.90±10.00	17.90±10.50	.564	.505	.927
Discharged home (%)	71.4	72.2	71.9	71.1	.600	.040	.006

NOTE. Values are means ± SD unless otherwise noted. Univariate tests of significance were performed with 1-way analysis of variance for continuous variables and chi-square tests for categorical variables.

Table 3
Coefficients and Odds Ratios From Multivariate Linear and Logistic Regression Models

Characteristic	Length of Stay		FIM Discharge		Home Discharge	
	b	95% CI	b	95% CI	OR	95% CI
Tier diabetes	0.00		0.00		1.00	
Nontier	2.35	(1.05 to 3.64)	5.98	(3.89 to 8.06)	1.56	(1.04 to 2.36)
No diabetes	2.39	(1.19 to 3.59)	8.24	(6.30 to 10.18)	1.76	(1.21 to 2.57)
Age (y)	-0.04	(-0.06 to -0.03)	-0.13	(-0.15 to -0.10)	0.99	(0.99 to 1.00)
Women	-0.09	(-0.19 to 0.00)	0.04	(-0.12 to 0.19)	1.19	(1.15 to 1.23)
Nonwhite	-0.59	(-0.70 to -0.47)	-1.46	(-1.65 to -1.28)	1.89	(1.82 to 1.96)
Comorbidities, sum	0.06	(0.04 to 0.08)	-0.11	(-0.14 to -0.08)	1.01	(1.00 to 1.01)
Onset to admission (d)	0.01	(0.01 to 0.01)	-0.06	(-0.07 to -0.06)	2.22	(2.15 to 2.29)
Hemorrhagic stroke	-0.35	(-0.49 to -0.21)	1.41	(1.19 to 1.63)	0.90	(0.87 to 0.94)
FIM admission	-0.26	(-0.26 to -0.26)	0.92	(0.92 to 0.92)	1.06	(1.06 to 1.07)
Tier * age	0.00		0.00		1.00	
Nontier * age	-0.03	(-0.05 to -0.01)	-0.08	(-0.11 to -0.05)	0.99	(0.99 to 1.00)
No diabetes * age	-0.03	(-0.05 to -0.02)	-0.10	(-0.13 to -0.07)	0.99	(0.99 to 1.00)

Abbreviations: b, unstandardized regression coefficient; OR, odds ratio; 95% CI, 95% confidence interval.

* Diabetes by age interaction term.