Research Report

An Analysis of the Relationship Between the Utilization of Physical Therapy Services and Outcomes for Patients With Acute Stroke

Background and Purpose. Little research has been conducted on the outcomes of care for people who have had a stroke. In this study, the relationship between physical therapy utilization and outcomes of care for patients with acute stroke was examined. Subjects. The sample consisted of 6,342 patients treated in US academic health center hospitals in 1996 who survived their inpatient stay and received physical therapy. Methods. The primary data source was the University HealthSystem Consortium Clinical Data Base. Physical therapy use was assessed by examining physical therapy charges. Outcomes of care were assessed in terms of the total cost of care (ie, whether the cost of care was more costly or less costly than expected, taking into account patient characteristics) and in terms of discharge destination (ie, whether the patient was discharged home or elsewhere). Regression analyses were conducted to examine the relationship between physical therapy use and outcomes. Results. Physical therapy use was directly related to a total cost of care that was less than expected and to an increased probability of discharge home. Conclusion and Discussion. The results of this study provide preliminary evidence to support the use of physical therapy in the acute care of patients with strokes and indicate the need for further study of this topic. [Freburger JK. An analysis of the relationship between the utilization of physical therapy services and outcomes of care for patients with acute stroke. *Phys Ther.* 1999;79:906–918.]

Key Words: *Health services research, Outcomes, Stroke.*

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Stroke is the leading cause of disability among adults in the United States.[1] Of the 550,000 individuals who have a stroke each year, approximately 75% survive and live with varying degrees of impairment or disability.[1] The economic burden of stroke is enormous and has been defined in terms of the direct costs for providing medical care and the indirect costs associated with lost productivity. In 1993, the direct and indirect costs of stroke were estimated to be $17 billion and $13 billion, respectively.[2] Lee et al[3] examined the costs of care during the initial 6 months post-stroke. They examined the National Claims History data file from the Health Care Financing Administration. For a 20% sample of patients receiving Medicare (n=32,407) admitted to an acute care hospital with a diagnosis of stroke in 1991, the average total cost of care for the first 6 months post-stroke was $18,626. Sixty percent of the post-stroke expense was incurred in acute care settings.

According to the Agency for Health Care Policy and Research clinical practice guidelines for post-stroke rehabilitation,[1] rehabilitation following a stroke begins during the acute hospitalization as soon as the diagnosis of stroke is established and life-threatening problems are under control. Physical therapy during the acute phase following a stroke usually focuses on increasing the patient's functional mobility and preparing the patient for discharge. Discharge from the acute care hospital to the patient's home, a rehabilitation setting, or extended care facility is dependent on the patient's medical stability, physical functioning, and endurance. For example, one of the threshold criteria for admission to a rehabilitation center is enough physical endurance to sit supported for 1 hour and to actively participate in the rehabilitation program (L Weil, Department of Physical Therapy, Rehabilitation Institute of Chicago, Chicago, Ill; personal communication; October 21, 1996). There is strong consensus among clinical experts that early mobilization (ie, active and passive range of motion, bed mobility, transfers, self-care, gait) of patients with an acute stroke is important,[1] and there is indirect evidence[4] to suggest that early mobilization also improves functional outcomes. Early mobilization of patients with an acute stroke may also decrease the total cost of the acute care phase by accelerating the time to discharge (ie, decreasing the length of stay, thereby decreasing the total cost of care[5]). In addition, early mobilization of patients with an acute stroke may influence discharge destination, which can have both patient and economic benefits. For example, early mobilization in the acute care setting may improve the functional mobility of the patient to the point that he or she can be discharged home, which likely has positive psychological benefits. Furthermore, the costs of care for a patient receiving rehabilitation services at home or in an outpatient setting are less than the costs of care for a patient receiving services in an inpatient setting such as a rehabilitation or skilled nursing facility.[3]

With the aging of the US population, stroke will continue to be a major health care problem. The proliferation of managed care and health care reform initiatives are also continuing to place an emphasis on the delivery of cost-effective and efficient health care. Unfortunately, little research has been conducted on the outcomes of care for patients with stroke who receive physical therapy in the acute care setting. The purpose of this study, therefore, was to examine the relationship between the amount of physical therapy services received by patients with an acute stroke and the outcomes of care for these patients. Outcomes of care were examined in terms of

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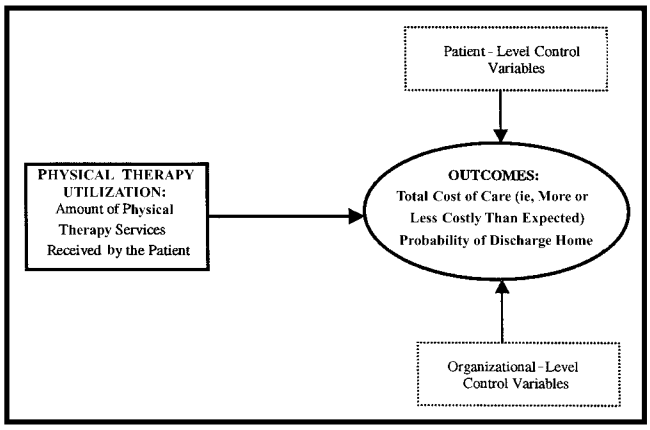

Figure 1.
Conceptual model of the study.

the total cost of care and in terms of discharge status. Total cost of care was assessed by determining whether the total cost was less costly than expected (a better outcome) or more costly than expected (a worse outcome), taking into account patient characteristics and the severity of the stroke. Discharge status was assessed by looking at the probability of the patient being discharged home. This study was conducted using secondary databases. Specific operational definitions of the study variables are provided in the "Method" section, following a description of the databases.

Method

In this study, I examined the acute care of patients with stroke who were treated in US academic health center (AHC) hospitals. Data obtained during 1996 were examined using a cross-sectional, correlational design. Figure 1 presents an overview of the conceptual model of the analysis. The relationship between utilization of physical therapy services and outcomes of care was examined while controlling for patient-level and organizational-level characteristics. Patient characteristics that would have an impact on the outcomes of care,[3,6–9] such as age, race, and severity of the stroke, were taken into account in the model. Likewise, characteristics of the AHC hospital where the patient received the care were taken into account to control for organizational factors that would have an impact on the outcomes of care.[3,5,9]

Figure 2 presents an overview of the methods used for this study. Data were extracted from 4 secondary databases. The data were evaluated for accuracy, and any inaccurate or improperly coded data were eliminated. The data were then merged to create a final data set that contained the study variables. Some preliminary analyses were conducted on the final data set to examine the distribution of the data, to detect outliers, and to verify that it was appropriate to perform regression analyses. Two separate regression analyses were then conducted. A multiple linear regression analysis was conducted to examine the relationship between utilization of physical therapy services and the total cost of care (ie, whether it was more costly or less costly than expected). I hypothesized that an increase in the use of physical therapy services would decrease a patient's length of stay and would, therefore, be directly related to a total cost of care that was less costly than expected. A multiple logistic regression analysis was also conducted to examine the relationship between utilization of physical therapy services and the probability of discharge home. I hypothesized that an increase in the use of physical therapy services would maximize a patient's function and would, therefore, be directly related to an increased probability of discharge home.

Data Sources

The major source of data for the study was the University HealthSystem Consortium (UHC) Clinical Data Base.[10] This database was used primarily to obtain information on patients with stroke who were treated in AHC hospitals in 1996. Other sources of data for the study were the Institutional Profile System (IPS) of the American Association of Medical Colleges,[11] the American Hospital Association (AHA) Annual Survey,[12] and the InterStudy Competitive Edge Database.[13] The latter 3 databases were used to obtain information on the AHC hospitals.

University HealthSystem Consortium Clinical Data Base. The UHC Clinical Data Base consists of clinical, administrative, and financial patient-level data from AHC hospitals in the United States.[10] Membership in the UHC is voluntary. In 1996, 64 AHC hospitals were members of the UHC.

The UHC Clinical Data Base is compiled from participating hospitals' discharge abstract summaries and UB-92 data. The discharge abstract summaries include information on each patient (eg, age, sex, race, admit date, primary diagnosis, secondary diagnosis, insurance) treated at the hospital. The UB-92 data include information on the charges for the services provided to each patient during his or her inpatient stay (eg, physical therapy charges). The UHC requires participating hospitals to submit their data semiannually following a standardized procedure and format to increase accuracy and to ensure consistency across hospitals.[14] A screening software program developed by the UHC is also available for participating institutions to assess the quality of their data prior to submission.[15] Participating institutions, however, are not required to use this software.

Once the data from a participating institution are received by the UHC, a screening is done to identify any records with inconsistent data or extreme outlier values.[15] The UHC sets tolerance thresholds for the number of exceptions or outlier values for critical variables in

the file. If data exceptions exceed established tolerance thresholds, UHC personnel reject the data submitted by a participating institution and request a resubmission with the errors corrected. In addition to screening the data submitted from each participating institution, UHC personnel examine the distribution of data from all participating institutions to help identify extreme outliers. Once data from a participating institution are screened and accepted by UHC personnel, the UHC provides the institution with a report on the outlier values to enable department managers to identify potential problem areas and improve data entry standards. Furthermore, those outliers that remain in the clinical database are flagged.

Although UHC staff have not conducted on-site studies to confirm the reliability or validity of data entry, they have standardized the data entry and submission process, are available for technical support visits to assist with data collection and editing, and conduct systematic data analyses prior to making the data available.[14,15] Furthermore, the UHC Clinical Data Base has successfully passed the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) standards to be an ORYX vendor (J Neikirk, A Juris, Data Services Division, University HealthSystem Consortium, Oak Brook, Ill; personal communication; May 12, 1999). Part of the ORYX initiative involves the creation of a national database that will contain performance measures on processes and outcomes of care in acute care hospitals.[16]

One advantage of the UHC Clinical Data Base is that it is risk-adjusted (ie, pertinent patient characteristics that may affect the outcomes of care are taken into account).[10] Specific details of the risk-adjustment methods used by the UHC are presented in one of their publications on the clinical database.[17] One portion of the risk-adjustment process used by the UHC consists of calculating an expected total cost of care for each patient in the database. This variable (ie, expected total cost of care) was used in this analysis. This portion of the risk-adjustment process, therefore, is summarized in the following paragraph.

The UHC personnel first assign a level of severity to each patient in a given diagnosis-related group (DRG) using the Sachs Complication Profile.[17] Patients classified in medical DRGs, such as DRG 14 for stroke, are categorized according to 3 severity levels: no substantial complications or comorbidities (0), moderate complications or comorbidities (1), and major complications or comorbidities (2). The UHC staff select a normative population to serve as the basis for the model (ie, records with outlier values are removed). A regression model is then developed to predict the expected total cost of care for each DRG. The independent variables in the model include severity level, total number of comorbidities, age, sex, race, admit source, Medicaid status, and the 5 most commonly performed procedures. The model also takes into account the geographic location of the hospital, which has an impact on the cost of care (ie, labor costs vary by location).[17] The regression model, which is based on the "mainstream" UHC Clinical Data Base population for each DRG, is then used to determine an expected total cost of care for each patient. The R^2 values for the UHC models predicting the expected total cost of care vary by DRG and range from 0.10 to 0.40. Values from 0.10 to 0.40 are fairly typical for risk-adjustment schemes and are considered useful for risk adjusting secondary databases.[17,18]

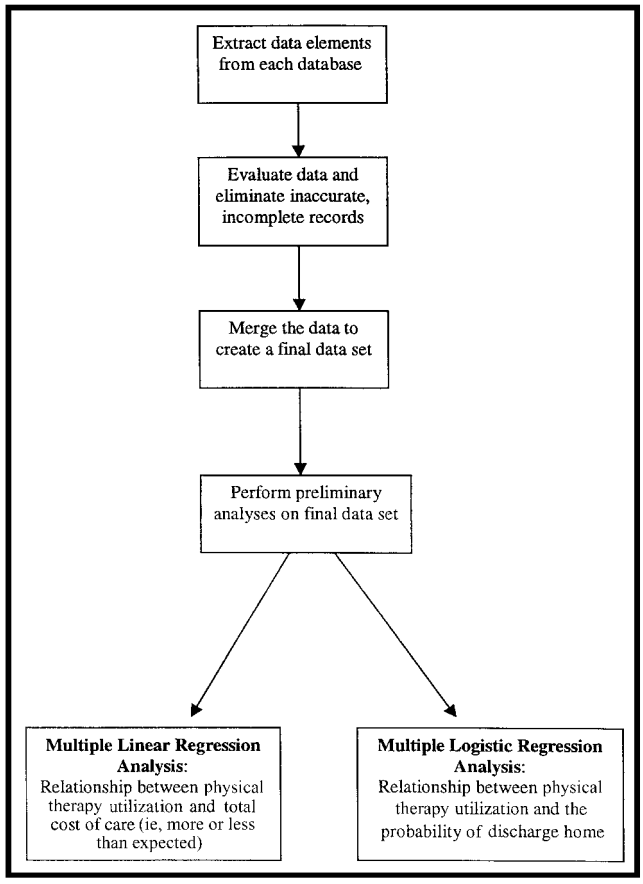

Figure 2.
Overview of the method.

Institutional Profile System of the American Association of Medical Colleges. The Institutional Profile System (IPS) is a database supported by the American Association of Medical Colleges.[11] The IPS houses descriptive data reported by all US medical schools. The database contains current and historical information relating to medical school revenues and expenditures, student enrollment and faculty counts, curriculum, capital expenditures, student financial aid, and tuition and fees.

American Hospital Association Annual Survey of Hospitals Database. The American Hospital Association (AHA) conducts an annual survey of more than 6,000 hospitals and health care systems. Responses to the survey are compiled in the AHA Annual Survey of Hospitals Database.[12] The AHA Annual Survey of Hospitals Database contains hospital-level data on organizational structure, service provision, physician arrangements, contracted care, community orientation, utilization, finances, personnel, and affiliations.

InterStudy Publications Competitive Edge Database. InterStudy Publications is a publisher of data, directories, and analyses of the managed care field.[13] InterStudy Publications tracks trends in health maintenance organization (HMO) services, enrollment, changes, and profitability. The InterStudy Publications Competitive Edge Database contains HMO industry information and market penetration data.

Sampling and Data Elements

Data from the UHC Clinical Data Base for the calendar year 1996 were examined in this study. Patient-level data for patients with stroke were identified by the DRG. The UHC staff assign a DRG classification to each patient based on his or her discharge diagnosis. Patients who were classified in DRG 14 (specific cerebrovascular disorders except transient ischemic attack) at the time of discharge, received physical therapy during their inpatient stay, and survived their inpatient stay constituted the sample.

The following data elements were extracted from the UHC Clinical Data Base on each patient: sex, race, age, length of stay, Medicaid status, type of stroke (ie, ischemic or hemorrhagic), total physical therapy charges, stroke severity level, total charges for care, discharge status (ie, whether patient went home or to another facility), actual total cost of care, and expected total cost of care.

Organizational-level data that were obtained from the UHC Clinical Data Base included the number of licensed beds for each AHC hospital in 1996. Organizational-level data for 1996 were also obtained from the IPS, the AHA Annual Survey of Hospitals Database, and the InterStudy Publications Competitive Edge Database. The IPS was used to gather the following data on medical schools affiliated with the AHC hospitals: type of affiliation between the medical school and the hospital, total dollars in research awards, and total number of faculty. The AHA annual survey was used to gather data on the ownership of the UHC hospitals (ie, public or private). The InterStudy Publications Competitive Edge Database was used to gather data on HMO market penetration in the metropolitan statistical areas occupied by each of the UHC hospitals.

The data elements extracted from the data sets were examined by doing frequency counts and performing standard univariate analyses. The final data set was created by excluding any observations with unreasonable, incorrectly coded, or incomplete data.

Measurement Variables

The dependent variable for the multiple linear regression analysis was the expected total cost of care/actual total cost of care for each patient. This ratio was multiplied by 100 for ease of interpretation of the statistical results. A better outcome, therefore, would be indicated by a number greater than 100, and a worse outcome would be indicated by a number less than 100. The dependent variable for the multiple logistic regression analysis was discharge status for each patient. This variable was dichotomized (ie, 0=discharge other, 1=discharge home).

The independent variable for the analysis was physical therapy utilization. Physical therapy utilization for each patient was represented by physical therapy charges/total charges. This ratio was multiplied by 100 for ease of interpretation of the statistical results. Physical therapy charges, therefore, were expressed as a percentage of total charges for the care of the patient. Physical therapy charges were represented in this manner to take into account variation in charges across AHC hospitals. An AHC hospital in an urban location, for example, may charge $100 for a physical therapy evaluation, whereas an AHC hospital in a suburban or more rural location may charge $65 for a physical therapy evaluation. This measure also takes into account variation in physical therapy charges due to differences in length of stay.

The patient-level control variables for the study were as follows: race (0=Caucasian, other; 1=African American), Medicaid status (0=receiving Medicaid, 1=not receiving Medicaid), age, stroke severity level (0=no substantial complications or comorbidities, 1=moderate complications or comorbidities, 2=major complications or comorbidities), type of stroke (0=ischemic, other; 1=hemorrhagic), sex (0=female, 1=male), and length of stay. A review of the literature indicated that these characteristics contribute to variation in the outcomes of care for patients with stroke.[3,5–9]

African-American patients and patients receiving Medicaid have been shown to use fewer health care services for the treatment of stroke than Caucasian patients and patients not receiving Medicaid.[8,9] The observed rates of in-hospital death for stroke have also been reported to be lower in African-American patients than in Caucasian

patients.[8] As would be expected, older patients and patients with more complications and comorbidities have poorer outcomes than younger patients and patients with fewer complications and comorbidities.[5,6] Hemorrhagic strokes also tend to be more acute and result in a higher rate of mortality relative to ischemic strokes.[3] Although the impact of sex and length of stay is less clear, there are some data to suggest that these variables contribute to variation in the outcomes of care for patients with stroke.[3,5,7]

The data for each patient were also coded with organizational indicators to control for some of the differences among the AHC hospitals. The organizational characteristics that were controlled for in this study were chosen for a combination of reasons that included the results of a literature review on AHC hospitals[19–22] and on the acute care of patients with stroke,[3,5,9] the type of data that were available, and the concepts of an organizational theory.[23,24] The organizational-level variables that were controlled for in the study were as follows: hospital ownership (0=public, 1=private), medical school affiliation (0=common affiliation of hospital and medical school, 1=other), medical school research intensity (total research grant and contract dollars/number of medical school faculty), number of beds, and HMO penetration (percentage of HMO penetration in the metropolitan statistical area of the AHC hospital). These variables are indirect measures of resource availability at the AHC hospital (eg, patient care revenues for public AHC hospitals are more scarce than patient care revenues for private AHC hospitals[25]) and were hypothesized to be related to outcomes of care. The AHC hospitals with scarcer resources were hypothesized to have more incentive or need to contain costs and improve outcomes than AHC hospitals with more abundant resources.

Data Analysis

All data were managed and analyzed using SAS Version 6.12 statistical software* on an IBM SP590 mainframe computer† running AIX. A univariate analysis of all of the study variables was conducted to examine the distribution of the data, to verify that each variable had sufficient variance, and to detect outliers. Some exploratory regression analyses and residual analyses were also conducted, and a correlation matrix was generated to examine the data for multicollinearity.[26] After the preliminary analyses, a multiple linear regression analysis was conducted to examine the relationship between physical therapy utilization (ie, physical therapy charges/total charges) and the expected total cost of care/actual total cost of care, while controlling for patient and organizational characteristics. A multiple logistic regression analysis was also conducted to examine the relationship between physical therapy utilization and the probability of discharge home, while controlling for patient and organizational characteristics. The explanatory power of the logistic regression equation was assessed with the Huberty test statistic.[27] The percentage of patients who were correctly classified (ie, either as discharged home or discharged elsewhere) using the logistic regression equation was compared with the percentage of patients who would be correctly classified by chance alone.

Table 1.
Characteristics of Academic Health Center Hospitals (N=59)

Characteristic	Frequency or $\bar{X}$ (SD)
No. of beds	553 (198)
Ownership	29 private, 30 public
Medical school affiliation	41 common affiliation of hospital and medical school 18 other type of ownership
Medical school research intensity (grant and contract dollars/no. of faculty)	$99,267 ($54,275)
Health maintenance organization penetration in catchment area of hospital	28% (15%)

Results

Of the 64 member hospitals that participated in the UHC Clinical Data Base in 1996, 59 hospitals submitted complete data on patient charges and were, therefore, included in the study. The final data set consisted of 6,342 records from these 59 hospitals. The mean number of records from each hospital was 107 (SD=70, range=14–295). Characteristics of the hospitals are presented in Table 1. The hospitals were located in 32 states and the District of Columbia. The following states were not represented: Alaska, Delaware, Hawaii, Idaho, Indiana, Louisiana, Maine, Maryland, Minnesota, Mississippi, Montana, Nevada, New Hampshire, North Dakota, Rhode Island, South Dakota, Vermont, and Wyoming. Because UHC requested that I maintain the anonymity of its members, the names of the hospitals are not presented.

Preliminary Analyses

The analysis began with 6,468 complete records on patients with strokes. The distribution of the variables were examined to detect outliers. About 1% of the records (n=63) were eliminated because of low total cost values. These records were in the 1st percentile and had total cost values ranging from $185 to $1,089.

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†International Business Machines Corp, New Orchard Rd, Armonk, NY 10504.

Table 2.
Definitions and Descriptive Statistics on Study Variables (n=6,342)

Variable Type	Variable Name[a]	Frequency or $\bar{X}$ (SD), Range
Dependent	Expected total cost of care/actual total cost of care) × 100	130.81 (84.75), 12.53–1,148.73
	Discharge status:	
	0=discharge other	0: 2,609 (41%)
	1=discharge home	1: 3,733 (59%)
Independent	Physical therapy utilization:	
	(physical therapy charges/total charges) × 100	3.49 (2.88), 0.02–30.63
Control	Age (y)	67.22 (15.67), 0–102
	Sex:	
	0=female	0: 3,345 (53%)
	1=male	1: 2,997 (47%)
	Race:	
	0=Caucasian/other	0: 4,423 (70%)
	1=African American	1: 1,919 (30%)
	Stroke severity level:	
	0=no substantial CCs	0: 3,572 (35%)
	1=moderate CCs	1: 5,327 (52%)
	2=major CCs	2: 1,344 (13%)
	Length of stay (d)	8.64 (7.59), 1–85
	Receiving Medicaid:	
	0=yes	0: 550 (9%)
	1=no	1: 5,792 (91%)
	Medical school affiliation:	
	0=other	0: 2,533 (40%)
	1=common ownership of hospital and medical school	1: 3,809 (60%)
	No. of beds:	
	No. of licensed beds for each UHC member institution	611 (225), 244–1,273
	HMO penetration:	
	% HMO penetration	26.02% (16.14%), 0%–66.80%
	Ownership:	
	0=public	0: 2,710 (43%)
	1=private	1: 3,632 (57%)
	Medical school research intensity:	
	Total grant and contract dollars/no. of faculty (in $100,000s)	$1.03 ($0.56), $0.08–$2.89

[a] CC=complications and comorbidities, UHC=University HealthSystem Consortium, HMO=health maintenance organization.

Records in the 99th percentile to the 100th percentile for total cost were also considered outliers because the increase in total cost from the 99th percentile to the 100th percentile was over 300% (from $46,411 to $194,986). These records (n=63), therefore, were also eliminated. The average cost of the acute care for a first-time patient with stroke has been reported to be $7,870.[3]

Descriptive statistics on patients in the final data set (n=6,342) are presented in Table 2. Because more than 50% of the patient records were missing information on the type of stroke (ie, ischemic or hemorrhagic), this variable was not included in the analyses. The patient characteristics of the final data set are consistent with previously reported data on the demographics of patients with stroke.[3,5,28] The variables of the eliminated records (n=126) were also examined with the use of descriptive statistics and were found to be similar to the final data set, indicating that the eliminated records differed from the final data set only in regard to total cost values.

Table 2 presents descriptive statistics for all of the variables used in the regression analyses. The mean total cost of care for a patient with stroke was $9,146 (SD=$7,283). The mean physical therapy charge for the acute care of a patient with stroke was $527 (SD=$724). Physical therapy charges, on average, represented 3% of the total charges for the care of a patient with stroke (Tab. 2) and ranged from less than 1% to 31% of the total charges.

Table 3.
Results of Multiple Linear Regression Analysis: Association of Variables With Natural Log of Expected Total Cost of Care/Actual Total Cost of Care[a]

Variable	Regression Coefficient (β)	Standard Error	*t*	*P*	Standardized Coefficient
SQPTCHGS[b]	**0.108**	**0.056**	**9.28**	**.0001**	**.117**
Age	**0.002**	**0.001**	**3.90**	**.0001**	**.052**
Sex	0.008	0.015	0.50	.6142	.006
Race	−0.015	0.017	−0.88	.3775	−.011
Stroke severity level	**0.064**	**0.012**	**5.49**	**.0001**	**.068**
Receiving Medicaid	0.003	0.028	0.10	.9207	.001
Medical school affiliation	−0.008	0.019	−0.42	.6778	−.006
No. of beds	**−0.004**	**0.001**	**−9.44**	**.0001**	**−.144**
Health maintenance organization penetration	**−0.002**	**0.001**	**−3.97**	**.0001**	**−.056**
Ownership	0.020	0.020	1.03	.3021	.016
Medical school research intensity	**0.092**	**0.019**	**4.87**	**.0001**	**.084**
Intercept	4.501	0.056	79.67	.0001	

[a] $F=23.89$, $P<.0001$, $R^2=.05$, significant variables ($P<.0001$) in boldface type.
[b] Square root of (physical therapy changes/total changes) × 100.

Multiple Linear Regression Analysis: Examination of the Relationship Between Utilization of Physical Therapy and Total Cost of Care

The dependent variable for this analysis was: (expected total cost of care/actual total cost of care) × 100. The independent variable for the analysis was: (physical therapy charges/total charges) × 100. Patient-level control variables for the analysis were age, sex, race, stroke severity level, and Medicaid status (Tab. 2). Length of stay was not used as a control variable in this portion of the analysis because the expected cost of care measure calculated by the UHC takes into account the expected length of stay for the patient. Organizational-level control variables for the analysis were medical school affiliation, number of beds, HMO penetration, ownership, and medical school research intensity (Tab. 2).

Preliminary residual analyses indicated that both the dependent variable and the independent variable were curvilinear, that is, increasing in an exponential manner. The variables, therefore, were transformed to linearize the data.[29] The dependent measure of expected total cost of care/actual total cost of care was transformed by taking the natural log of the value. Physical therapy utilization was transformed by taking the square root of the value (ie, square root of physical therapy charges/total charges). Residual analyses also indicated that the assumptions of the multiple regression analysis were generally not violated.[26]

The results of the multiple linear regression analysis are presented in Table 3. Physical therapy utilization (ie, [square root of physical therapy charges/total charges] × 100) was directly associated with a total cost of care that was less than expected ($\beta=0.108$, $P<.001$). That is, increased use of physical therapy services was associated with a better outcome in terms of cost. Other patient-level control variables that were directly associated with a total cost of care that was less than expected ($P<.001$) were age ($\beta=0.002$) and stroke severity level ($\beta=0.064$). Organizational-level control variables that were statistically significant ($P<.0001$) were number of beds ($\beta=-0.004$), HMO penetration ($\beta=-0.002$), and medical school research intensity ($\beta=0.092$). The standardized regression coefficients indicate that physical therapy utilization and number of beds were the 2 variables that explained most of the variation in the total cost of care measure with values of .117 and −.144, respectively. Although several of the variables contributed to explaining some of the variation in the total cost of care measure, the R^2 value of .05 indicates that additional independent or control variables are needed to explain more of the variation in this measure.

Multiple Logistic Regression Analysis: Examination of the Relationship Between Utilization of Physical Therapy and Discharge Status

The dependent variable for the analysis was discharge status (ie, discharge to home or elsewhere). The independent variable for the analysis was: (physical therapy charges/total charges) × 100. The patient-level control variables for the analysis were age, sex, race, stroke severity level, Medicaid status, and length of stay (Tab. 2). Controlling for length of stay was an additional way of taking into account the severity of the patient's stroke. For example, patients with shorter lengths of stay were likely those with minimal residual deficits, increasing the likelihood that they would be discharged home. Conversely, patients with longer lengths of stay were likely those with deficits or medical problems in need of inpatient rehabilitation or extended care, regardless of the amount of physical therapy received during the acute phase. The organizational-level control variables for the analysis were medical school affiliation, number

Table 4.
Results of Multiple Logistic Regression Analysis: Association of Variables With Probability of Discharge Home[a]

Variable	Regression Coefficient (β)	Standard Error	χ^2	*P*	Standardized Coefficient
Physical therapy utilization[b]	**0.0307**	**0.0097**	**10.13**	**.0015**	**0.049**
Age	**−0.0241**	**0.0020**	**153.04**	**.0001**	**−.208**
Sex	0.0389	0.0538	0.52	.4703	.011
Race	**0.2290**	**0.0606**	**14.28**	**.0002**	**.058**
Stroke severity level	**−0.2314**	**0.0431**	**28.79**	**.0001**	**−.084**
Receiving Medicaid	−0.0006	0.1026	0.00	.9954	.000
Length of stay	**−0.0428**	**0.0041**	**111.59**	**.0001**	**−.179**
Medical school affiliation	−0.0004	0.0674	0.00	.9958	−.000
No. of beds	**0.0004**	**0.0001**	**9.04**	**.0026**	**.055**
Health maintenance organization penetration	−0.0027	0.0019	2.02	.1545	−.024
Ownership	**−0.1358**	**0.0688**	**3.90**	**.0483**	**−.037**
Medical school research intensity	**0.1464**	**0.0656**	**4.98**	**.0256**	**.046**
Intercept	2.1059	0.1965	114.87	.0001	

[a] −2 log-likelihood=8591.62, χ^2=489.41, significance level *P*=.0001. Observations correctly classified=64%. Significant variables ($P \leq .05$) in boldface type.
[b] (Physical therapy changes/total changes) × 100.

of beds, HMO penetration, ownership, and medical school research intensity (Tab. 2).

The multiple logistic regression equation was modeled after the probability of discharge home. The results of the analysis are presented in Table 4. Physical therapy utilization (ie, [physical therapy charges/total charges] × 100) was positively associated with an increased probability of discharge home (β=0.0307, $P<.05$). Statistically significant patient-level control variables ($P<.05$) were age (β=−0.0241), stroke severity level (β=−0.2314), race (β=0.2290), and length of stay (β=−0.0428). Statistically significant organizational-level control variables ($P<.05$) were number of beds (β=0.0004), medical school research intensity (β=0.1464), and ownership (β=−0.1358). The standardized regression coefficients indicate that age and length of stay are the most influential variables in predicting the probability of discharge home, with values of −.208 and −.179, respectively. The equation generated in the analysis correctly predicted the discharge status of 64% of the patients, and this percentage was significantly higher (*P*=.05) than the chance prediction rate of 52%.

Discussion

The results of this study indicate that increased utilization of physical therapy during the acute care of patients with strokes is associated with: (1) a total cost of care that is less than expected and (2) a greater probability of discharge home.

Relationship Between Physical Therapy Utilization and Total Cost of Care

Although the explanatory power of the multiple linear regression model in this study was weak, the statistically significant and positive association between physical therapy use and a total cost of care that was less costly than expected is an important finding, particularly because of the large sample size used in the analysis. Furthermore, the variable representing physical therapy use was 1 of 2 variables that explained most of the variation in the total cost of care (Tab. 3). The fact that the multiple linear regression equation in this study explained only a small portion of the variance in the total cost of care is not surprising, considering the small number of independent and control variables that were used to explain variation in a dependent measure with a large standard deviation (Tab. 2). R^2 values from .05 to .10 are not uncommon when using multiple linear regression equations to examine large samples of patient-level outcomes data[18,30,31] and, despite the low explanatory power of the models, still provide useful information for understanding factors that contribute to variation in the outcomes of care.

Based on the results of the multiple linear regression equation, a 1% increase in the ratio of physical therapy charges to total charges is associated with a 1% increase in the ratio of expected total cost of care to actual total cost of care, holding all other variables constant. That is, a 1% increase in physical therapy utilization is associated with a decrease in the actual total cost of care. One explanation for this finding is that increasing the use of physical therapy services decreases the total cost of care by accelerating the time to discharge. This concept can be further illustrated by using mean values from the data set. The mean expected total cost of care for the data set was $8,248, and the mean actual total cost of care was $9,145 (ie, 90%). A 1% increase in this value could be gained by an $81 decrease in the actual cost of care. Increasing the utilization of physical therapy by 1% (ie, increasing the ratio of physical therapy charges to total charges by 1%) would be associated with an $81

decrease in the total cost of care. Although these cost savings may seem small, the savings are significant when applied to the thousands of patients with strokes treated each year in the United States.

Although this example may better illustrate the results of this study, the reader is cautioned about the interpretation of the results. Although physical therapy use explains a small portion of the variation in the expected total cost of care/actual total cost of care, much of the variation in this variable is still unexplained. The value of the regression coefficient representing the relationship between physical therapy use and the total cost of care would likely change, at least slightly, with the inclusion of other statistically significant independent or control variables.

Relationship Between Physical Therapy Utilization and the Probability of Discharge Home

The explanatory power of the multiple logistic regression model in this study was fair,[27] with 64% of the patients correctly classified as either discharged home or discharged elsewhere (Tab. 4). Although the standardized regression coefficients indicate that the patient-level control variables of age and length of stay explained most of the variation in the probability of discharge home (Tab. 4), the statistically significant association between the use of physical therapy services and the probability of discharge home is notable. This finding seems particularly relevant because stroke severity level and length of stay were controlled for in the analysis. That is, for those patients who were most likely to be discharged home (ie, the patients with lower stroke severity levels and shorter lengths of stay), the amount of physical therapy they received increased the probability that this would occur.

As with the results of the multiple linear regression analysis, the results of the multiple logistic regression analysis can be used to illustrate how physical therapy use affects the probability of discharge home. Using values to represent an "average" patient with stroke (eg, 67 years of age, female, Caucasian, stroke severity level=1) treated in an "average" AHC hospital (eg, number of beds=611, public ownership), the probability of discharge home with zero physical therapy charges (ie, physical therapy charges/total charges=0) is P=.52. If the ratio of physical therapy charges to total charges is increased to 3%, the probability of discharge home increases to P=.59. One plausible explanation for this finding, is that an increase in the use of physical therapy services increases the probability of discharge home by maximizing the patient's function. Again, the reader is cautioned about the interpretation of these results. The logistic regression equation generated in this analysis did not explain all of the variation in the probability of discharge home. Furthermore, specific values for the patient and hospital characteristics were used to come up with the above example. The probability of discharge home would change if different values were used. For example, if an age of 60 years was used instead of an age of 67 years, the probability of discharge home would increase.

Control Variables

Of the patient-level control variables, age and stroke severity level were statistically significant in both regression analyses. As might be expected, age and stroke severity level were inversely related to an increased probability of discharge home (Tab. 4). Age and stroke severity level, however, were directly related to a total cost of care that was less than expected (Tab. 3). Length of stay and race were also statistically significant patient-level variables in the logistic regression analysis (Tab. 4). Length of stay was inversely related to the probability of discharge home, as might be expected, and African-American patients were more likely than Caucasian patients to be discharged home. The findings for the African-American patients are consistent with findings reported by Gordon et al.[8]

The organizational-level control variables that were statistically significant varied somewhat for each of the regression models (Tabs. 3 and 4). Of particular note was the measure of medical school research intensity, which was statistically significant and positive in both regression analyses (ie, directly related to a total cost of care that was less than expected and to an increased probability of discharge home). A possible explanation for this finding is that fiscal constraints of AHC hospitals affiliated with research-intensive medical schools may provide the pressure or incentives to contain costs. Although medical school researchers bring in money for the institution through external funding, they are often unable to fully recover the costs of research[32,33] and may rely on clinical revenues to supplement externally funded research and to cover uncompensated research costs.[32–34] An alternative explanation for these findings may be that medical school research intensity is an indirect measure that reflects the application of the latest and most effective techniques for patient care and that presumably leads to better outcomes. Research-intensive AHCs may more readily apply the results of their studies when compared with non–research-intensive AHCs. Furthermore, research-intensive AHCs may have health care providers who are more informed of the current advances in health care research. Currently, however, no data are available to support or refute these explanations.

The somewhat inconsistent findings with the other organizational-level control variables used in the analysis

are not surprising. Although research indicates there is variation among hospitals in the outcomes of care for the treatment of patients with stroke, even after controlling for patient differences,[3,5,9] the sources of this variation are less clear. Some of the inconsistencies may also be due to differences in the dependent variables used in the 2 analyses. Nevertheless, the results of this study provide additional information to indicate that organizational characteristics of the institution have some impact on outcomes of care.

Strengths and Limitations of the Study

This study was exploratory in nature, using a limited model and research design to examine the relationship between physical therapy utilization and outcomes of care. The primary source of data for the study was the UHC Clinical Data Base.[10] This database is useful because it contains patient-level information on physical therapy charges and because it provides risk-adjusted measures of outcomes of care. One strength of using secondary databases, such as the UHC Clinical Data Base, is that thousands of patient records can be analyzed. Studies using secondary databases also are generally less expensive to conduct than studies requiring primary data collection.[18]

A weakness of using secondary databases is that it is difficult to completely verify the accuracy of the data they contain. Although the UHC has a number of processes in place to increase the accuracy of the data in the clinical database and although the data extracted in this study were examined for outliers, there is still the possibility that some of the data in the sample were coded inaccurately. The fact that the characteristics of the subjects in the sample were similar to previously reported data on the demographics of patients with stroke offers some evidence to support the accuracy of the data entry. The UHC's process of analyzing the accuracy of the data also is fairly thorough. Finally, the results of the study are robust to a small percentage of inaccurate entries due to the size of the sample (n=6,342).

The range of research opportunities with secondary databases is also limited by the variables included in the database. The fact that neither of the regression analyses in this study explained a high percentage of the variation in the dependent measures suggests that additional variables are needed in the models. Inclusion of more patient-level variables would likely explain more of the variation in the dependent variables, especially because the dependent variables were measured at the patient level. Including the types of physical therapy treatments that were received, for example, might have improved the fit of the models. Better measures of stroke severity and functional status of the patient prior to admission might have improved the fit of the models by providing better control for a source of variation among the patients. Finally, including the utilization of other ancillary services, such as occupational therapy and social work, might have improved the fit of the models. Additional organizational-level control variables might have also improved the fit of the regression models. Physician mix (eg, number of neurologists at the AHC hospital) is an example of an organizational-level variable that might have explained more of the variation in the dependent measures.[35] The patient/nurse ratio at the AHC hospital is another example of an organizational-level variable that might have explained more of the variation in the dependent measures.

In addition to the need for more independent or control variables in the regression models used in this study, this study had other limitations. Although the results indicate that increased physical therapy utilization is related to a total cost of care that is less costly than expected and to an increased probability of discharge home for patients with strokes, the cross-sectional design of the study precludes any conclusions on a cause-effect relationship. It cannot be assumed that physical therapy use is the direct cause for these outcomes.

The external validity of the study also was limited because the data set consisted of data from AHC hospitals that were members of the UHC. Membership in the UHC is voluntary, and, in 1996, the consortium represented approximately half of all AHC hospitals in the United States. Although many states were represented in the analyses, some states were not represented. Furthermore, those hospitals that participate in the UHC may have incentives or agendas that make them different from those hospitals that do not participate.

The independent variable used in the analyses was also limited. Although physical therapy charges/total charges seems to be an appropriate measure for utilization of physical therapy services, it does not provide any information on the types of treatment that were provided for the patient. The information on physical therapy charges for a given patient was obtained by summing all of the charges associated with the UB-92 revenue codes for physical therapy. Although it seems unlikely that charges for physical therapy in an AHC hospital would be made by health care providers other than physical therapists or physical therapist assistants, the measure of physical therapy charges used in this study did not distinguish between the care provided by a physical therapist and the care provided by a physical therapist assistant. Whether care provided by physical therapy aides was included in the physical therapy charges is also unclear from these data.

The dependent measures used in the analyses were also limited. The measure of expected total cost of care/actual total cost of care was calculated relative to the norm of UHC members. Whether the expected total cost of care value calculated by UHC reflects the *most* efficient outcome in terms of cost of care is unknown. How the expected total cost of care value relates to the cost of care at other AHC hospitals that are not members of the UHC or at other community hospitals is also unknown. Furthermore, although the UHC process for calculating an expected total cost of care appears to have face validity and content validity, there are no studies that validate this process. Finally, the validity of discharge home as an indication of a more optimal functional outcome may also be questioned. Some patients, for example, may be discharged home with poor functional status because they have the resources to get the care they need or because they have appropriate family support. Conversely, some patients may be functioning at a fairly high level but lack the social network or resources to be discharged home without being fully independent. Although it may be argued that discharge status is not a valid measure of functional status, being discharged home likely benefits the patient in other ways. For example, the psychological effects of being discharged home after a stroke, versus being discharged to a rehabilitation or extended care facility, are likely positive.

Despite the limitations, this study provides preliminary evidence that supports the use of physical therapy services for the acute care of patients with strokes treated at AHC hospitals. In addition to being associated with a total cost of care that was less costly than expected, physical therapy use was associated with an increased probability of discharge home, which also has economic benefits. Viewing the use of physical therapy from an economic perspective is particularly timely and relevant with the current climate in health care and with the implementation of the Balanced Budget Act of 1997.[36] Although there is general consensus that physical therapy is an important component of the acute care for patients with strokes,[1] there are few data to support its effectiveness.

The findings of this study indicate that continued analysis of this topic is warranted. More sophisticated models are needed to explain more of the variation in the total cost of care and probability of discharge home. Longitudinal analyses would also be appropriate to establish a cause-effect relationship between physical therapy utilization and outcomes of care. Finding measures of physical therapy utilization that are more specific to the types of treatment given and measures of outcome that are more specific to the functional status of the patient would also be useful. Because the acute care of the patient with stroke is a multidisciplinary effort, furthering our understanding of the interplay between physical therapy utilization and the utilization of other ancillary services would also be useful. Finally, furthering our understanding of how organizational characteristics of the AHC hospital affect outcomes of care would be useful.

Conclusion

In this study, I examined the relationship between physical therapy utilization and outcomes of care for patients with acute stroke. The results indicate that physical therapy utilization was directly related to a total cost of care that was less costly than expected and to an increased probability of discharge home. Further studies are needed to determine additional factors that contribute to variation in the total cost of care and in the probability of discharge home.

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