Department of Veterans Affairs

Journal of Rehabilitation Research and Development Vol. 37 No. 4, July/August 2000
Pages 483–491

CLINICAL REPORT

The structure and structural effects of VA rehabilitation bedservice care for stroke

Dean M. Reker, PhD, RN; Helen Hoenig, MD; Michael A. Zolkewitz, BS; Richard Sloane, MS, MPH; Ronnie D. Horner, PhD; Byron B. Hamilton, MD, PhD; Pamela W. Duncan, PhD, PT.
VA Medical Center, Kansas City and the Center on Aging, Kansas University Medical Center, Kansas City, KS.; Health Services Research and Development and Epidemiology Research and Information Center (ERIC), Durham VA Medical Center; Dept of Medicine, Duke University Medical Center; Physical Medicine and Rehabilitation Service, Durham VA Medical Center; Center for the Study on Aging, Duke University Medical Center.

Abstract—The purpose of this study was to: 1) examine the variation in organizational structure within rehabilitation bedservice units (RBU) in the Veterans Health Administration (VHA), and 2) evaluate the effects of RBU and parent hospital structure on stroke rehabilitation outcomes. Two VHA-wide surveys of acute and rehabilitation services for stroke were linked with 2 y of VHA rehabilitation outcomes for stroke patients. A random effects mixed model was used to adjust for patient level covariates, control for unique site effects, and test for facility level structural effects. After adjusting for patient covariates, four structural variables were associated with length of stay or patient functional gain. These results indicate that rehabilitation structure is important to rehabilitation outcome. The individual variables identified in this study, namely, diverse multidisciplinary staff, expert physician leadership, staff participation in team care, and richer rehabilitation equipment resources, may represent the distinct aspects of a successful, comprehensive rehabilitation unit.

Key words: *outcomes, rehabilitation, stroke, structure*

This material is based on work supported by the Health Services Research and Development Service and the Rehabilitation Research and Development Service, Office of Research and Development, Veterans Health Administration, Department of Veterans Affairs.

Address all correspondence and requests for reprints to: Dean M. Reker, PhD, RN, VA Medical Center, Kansas City and the Center on Aging, Kansas University Medical Center, Kansas City, KS; email:dreker@kumc.edu

INTRODUCTION

Over the past 20–30 years, there have been over 150 published evaluation studies in rehabilitation medicine and, particularly, stroke rehabilitation. These studies indicate with consistency that stroke patients who received rehabilitation services experienced improved short- and longer-term survival, higher function, return home and, perhaps, better quality of life (1–9).

It is apparent from these studies that major organizational characteristics of stroke rehabilitation care can exert significant effects on patient outcomes. The literature is less revealing, however, as to the specificity and detail of the structural and process factors that are associated with the improved outcomes. One recent study reports the following characteristics of stroke units to be key factors: teamwork, staff education, functional training, and integrated physiotherapy and nursing (10). However, the study was not designed to test associations between the specific characteristics and patient outcomes. Another study indicated the time to initiation of rehabilitation was important (1).

In an effort to identify specific components of structure and process associated with improved patient outcomes, we initiated a study of the organizational structure of rehabilitation bedservice units (RBUs) of the Physical

Medicine and Rehabilitation Service (PM&RS) of the Veterans Health Administration (VHA). We examined the associations between specific structures and stroke patient outcomes (patient functional gain, length of stay (LOS), discharge location).

As our theoretical model to guide this study, we used the structure, process, outcome (SPO) model of health care quality described by Donabedian (11). The model can be schematically illustrated as:STRUCTURE→PROCESS→OUTCOME where the structures of health care organizations affect the internal and external processes of the organization, and ultimately these processes affect the outcomes or products of the organization. As defined by Donebedian, structural components "have a propensity to influence the process of care" and "changes in the process of care, including variations in its quality, will influence the effect of care on health status, broadly defined" (p.84). Hence, structural effects on outcomes are thought to be mediated through process.

METHODS

Design

This study is a secondary analysis of two VHA surveys of acute and post-acute stroke organizational resources, administrative data, and 2 years of stroke rehabilitation outcome data. These data were merged to create the study data set for 59 VA rehabilitation bedservice units (RBU) representing the highest level of rehabilitation care within the VA health care system.

Data Sources

Data were obtained from mailed surveys of: 1) VA Physical Medicine and Rehabilitation Service (PM&RS); and, 2) VA hospital and acute stroke services.

Study 1. VA Rehabilitation Medical Services.

This 1996 survey contains information from 149 VA medical centers regarding rehabilitation resources in 4 general areas: personnel (e.g., staffing), physical facilities (e.g., equipment), coordination of care (e.g., guidelines), and hospital characteristics (e.g., post-acute settings, university affiliations). The response rate for this mailed survey was 100 percent. Details of the survey are reported elsewhere (12).

Study 2. VA Acute Stroke Services.

As part of the VA Acute Stroke Study (Clinical Management and Outcomes of Stroke Patients at VA Medical Centers (SDR 93-003)), this survey identified acute care resources for care of stroke patients in two general areas: personnel (e.g., staffing) and facility characteristics (e.g., diagnostic equipment, specialty units) at 155 VA medical centers that provided acute care to stroke patients in 1994. Five VA facilities that responded to the PM&RS Survey that had not responded to the Acute Care Survey (144 out of 149 facilities had a VA Acute Care Survey). The response rate for the Acute Stroke Services survey was 98 percent.

To augment the survey data, VHA administrative data on staffing and workload were obtained from the Veterans Affairs Central Office (VACO) Personnel and Accounting Integrated Database (PAID) and the Resource Planning and Management Workload Database (RPM). From the PAID, we obtained employee level data consisting of job title, salary, and education level. All PM&RS staff, relevant nursing staff, and therapists paid through cost centers other than PM&RS were included in the human resources tallies. From the RPM we obtained rehabilitation workload. Rehabilitation workload was based on the number of patients treated in a facility that were considered intensive rehabilitation consumers. High users were: inpatients with spinal cord injuries, traumatic brain injuries, or stroke; nursing home patients receiving five or more physical therapy (PT) or occupational therapy (OT) visits per wk; and outpatients with more than 6 visits/y to rehabilitation outpatient services. Average costs for each unique patient group were multiplied by the number of patients in each group and summed across the high users group to obtain rehabilitation workload. If patients received care at more than one VA hospital, the workload for that patient was prorated to each facility. Facility workload was calculated from RPM data for the period Oct 1, 1994 through Sept 30, 1995.

VHA Rehabilitation Outcome Data

Each RBU in the VHA participates in the Uniform Data System for Medical Rehabilitation (13), a national data management service that collects and reports VA patient demographics, function, and outcomes (referred to as VA-UDS2 database). Outcome data, adjusted for patient level covariates, were retrieved from the VA-UDS database for two fiscal years: Oct 1, 1994 through Sept 30, 1996. Outcome data used in these analyses consisted of: 1) patient functional gain as measured by the Functional Independence Measure (FIM) points; 2) rehabilitation length of stay (logged); and, 3) discharge to community (dichotomous). The outcome data were avail-

able on 2,982 stroke rehabilitation patients from 59 VHA RBUs selecting only those patients classified as "new admissions" and omitting patients classified as "re-admissions" (n=364). This analysis used the unidimensional summary FIM score as the outcome of interest rather than the separate motor and cognitive subscales of the FIM. The summary FIM score has been shown equivalent to using subscales when case-mix adjusting at the facility level (14).

Database Development

Because of the richness of the data set and a high likelihood of redundancy (co-linearity) among variables, we sought a succinct subset of variables to characterized key structural elements (12). The first step in the variable reduction process involved eliminating variables with little or no variation and those with extreme outliers. We also created summary variables through combinations (i.e., individual disciplines attending rounds were summed to create "number of disciplines at rounds"; individual physical barriers (steps, closed doors, curbs) were summed to create a "total barriers score").

The second step toward variable reduction used an expert panel and a modified Delphi process to identify the most relevant variables that may affect patient outcomes. The expert panel consisted of 14 VA and non-VA representatives from the fields of architectural research, geriatric medicine, kinesiotherapy, nursing, occupational therapy, physical medicine, physical therapy, psychology, recreational therapy, and speech therapy. The panel formed consensus on the clinical relevance of the candidate taxonomy variable by using two rounds of a modified Delphi process (15). In a modified Delphi process, individuals are typically polled separately via self-administered questionnaire. The process is repeated several times, and after each round, results are summarized and reported to all participants. For this research, each participant was asked to rate the clinical relevance of the variables, based on their clinical experience and/or familiarity with the research literature, using a nine point scale (one=no effect on functional outcomes; five=some effect (either positive or negative) but not long-lasting and of limited clinical importance; nine=effect (either positive or negative) that was long lasting or clinically important). Following the first survey round, the results were summarized (group median and range) and reported to the respondents with instructions to re-rate each of the variables considering the new information. In the end, taxonomy variables were deemed clinically important if 85 percent of panel members scored the category of variables with values from six through nine (again, on a scale of one to nine).

In the third step, univariate correlations were generated between individual structure variables and the intensity level of post-acute services (4 levels: 0) no post-acute services, 1) nursing home or intermediate care only, 2) geriatric evaluation and management units (GEM), and 3) RBU). If statistically significant correlations ($p<0.05$) existed between the individual structure variable and the intensity level of services, the structure variable was determined to possess policy relevance and was included in the final set of variables. The results of steps 1–3 identified 30 variables selected for further analysis relative to outcomes.

Key Variables

The final set of structural variables was divided into four domains: personnel, physical facilities, coordination of care, and hospital characteristics. Workload ratio variables for medical doctors (MDs), physical therapists (PTs), occupational therapists (OTs), and speech and language pathologists (SLPs) in the personnel domain were created by dividing the net number of rehabilitation personnel in each discipline by the workload factor for rehabilitation (as described above). The registered nurse (RN) workload measure was calculated using the RN staffing for the entire hospital. Lower workload ratios represent higher workloads for individual clinicians.

The remaining variables in the personnel domain were defined as follows: diversity of allied health professions is the sum of the number of different disciplines on staff at that facility (physical therapists, kinesiotherapists (KT), occupational therapists, speech and language pathologists, and recreational therapists (RT) were counted). The number of new graduate therapists was the number of therapists on staff that have less than 1 y of clinical experience since graduation. The ratio of professional therapists was the number of physical therapists divided by the sum of physical therapists, physical therapy assistants, and physical therapy aides. Tuition represented the reimbursement amounts for educational expenses to PTs, PT assistants, OTs, and OT assistants for Fiscal Year (FY) 1995 (Oct 1, 1994 through Sept 30, 1995; from the Office of Employee Education). The diversity of acute care specialists was the number of different types of specialty physicians pertinent to acute stroke care on the hospital medical staff. The final two personnel variables indicated

whether the VA facility reported having a nurse specialist or PT specialist for stroke care.

The four physical facilities variables included: the net number of different types of rehabilitation equipment, the use of prefabricated ankle foot orthoses, the presence of a simulated home environment, and the presence of an adaptive kitchen.

Coordination of care variables was defined as follows. The number of disciplines at rounds was the average number of allied health disciplines that routinely attend patient care rounds. The variable stroke guideline was whether or not the facility had actively implemented a formal or informal clinical stroke guideline or algorithm. The third coordination of care variable was whether each facility used a paid escort service for patient transport. The final coordination variable measures whether or not the therapist treating the patient attended patient care rounds or if another therapist provided a report on the patient.

Hospital characteristic variables included: the number of rehabilitation training programs for PTs, OTs, PT assistants, OT assistants, and KTs, and SLP programs; rehabilitation workload (in arbitrary units); total hospital beds; number of settings where stroke patients received care; number of post-acute care settings; the presence of a joint affiliation with an academic medical center; the presence of VA-owned home health services; the availability of rehabilitation services on weekends; the presence of a recent organizational change in the hospital; and the proportion of outpatients traveling more than one hour from their home to their clinic appointment.

Data Analysis

A multivariate statistical model was chosen for data analysis in order to control for multiple patient characteristics and unique, unmeasured "site" effects. These techniques make statistical allowances for patient and hospital differences while allowing an impartial test of independent variable effects on patient outcomes. Because patients were nested within site, we used mixed modeling (SAS (SAS Institute, Inc., Cary, NC): proc mixed; glimmix procedure for dichotomous community discharge) to test facility level variables while controlling for: 1) unmeasured and unique "site" effects; and, 2) patient level covariates.

The multivariate modeling was performed in a two-stage process for each of the three dependent variables. During the first stage, a separate multivariate analysis was performed for each structure variable within each dependent variable. If the structure variable was statistically significant at $p<0.10$, the variable was retained for the stage two analysis. Due to the exploratory nature of the variable identification process, we used $p<0.10$ as a cutoff for inclusion. Site was used as a classification variable and a uniform set of patient covariates (described below) was used in each multivariate test to adjust for patient case-mix.

All structure variables surviving stage one were entered into the final modeling sequence and eliminated, one at a time (backward elimination), if statistical significance (p) was not equal to or less than 0.05. The final model for each dependent variable contained site as a classification variable, the uniform set of patient covariates to adjust for casemix, and all study structure variables significant at $p<0.05$.

Patient Covariates

The following patient characteristics were selected from the VA-UDS database and used as patient level covariates to adjust for case-mix differences between patient groups in differing facilities: admission FIM score (admission severity), age (y), age/admission FIM interaction, onset duration (stroke onset to rehabilitation admission in days), year of discharge (1995 or 1996), source of admission (percent of patients transferred in from another acute facility) (3), marital status (married or not married), race (white or not white), LOS (logged; used in Functional gain and Community Discharge models), and co-morbidity (Charlson index, truncated at three in order to reduce skewed distribution).

RESULTS

Patient Sample

Characteristics of the patient sample are shown in **Table 1**. Fifty-nine VHA RBUs treated 2,982 new admission stroke rehabilitation patients during FY 1995 and FY 1996 (**Table 1**). The average age of patients was 67 years; 52 percent were married and 68 percent were Caucasian. The mean time from stroke onset to admission (rehabilitation admission date minus stroke onset date) was 31 days. The average co-morbidity index (Charlson) was 0.45. The mean admission FIM score was 73; the discharge FIM was 95, with an average FIM gain of 22 points per patient. Nineteen percent (19 percent) of the patient sample were transferred in for rehabilitation. The distribution of the patient sample by year of discharge was 51 percent for 1995 and 49 percent for 1996.

Table 1.
Characteristics (patient level) of 2,982 stroke patients in 59 VHA RBUs.

Parameter	Mean	SD	Min	Max
Age	67	10	25	101
Married	52%			
Race (Caucasian)	68%			
Onset days	31	47	0	364
Comorbidity Index	0.45	0.81	0	12
Admission FIM	73	26	18	126
Discharge FIM	95	25	18	126
Source of admission (% from another acute)	19%			
Year of discharge (% in 1995)	51%			

Organizational Structure

Table 2 shows the profile of the RBUs as defined by our reduced organizational structure variables. Variation in most of the structural components was substantial.

Patient Outcomes

In **Table 3**, unadjusted patient outcomes by site are presented. There was a wide range in site-level outcomes with 3–6 fold differences between the lowest and highest site averages.

Association Between Structure and Outcomes

Table 4 presents the results of the multivariate mixed effects modeling wherein we link each specific structure with outcomes, adjusting for other important structural components. For conciseness, only those factors that are the statistically significant covariates and structure variables are listed in the table (full data available from the authors on request). Admission severity (in total FIM points) appeared as a significant covariate in all three dependent variable models. Patients more severely affected at the time of admission were likely to have longer lengths of stay, make greater functional gains, and have lower frequencies of discharge to the community. Age was an important modifier of the effect of admission severity on patient outcomes for functional gain and community discharge. Age does not appear to have any affect on functional gain and community discharge for very mild strokes; however, as the stroke becomes more severe, the effect of age has greater negative impacts on these two patient outcomes. The age/admission severity interaction for LOS was more consistent across all levels of patient severity. Younger and more severely affected

Table 2.
Structure of VA Bedservice Care--Facility level data from 59 VHA RBUs.

Organizational Variable	Mean	SD	Min	Max
Personnel				
MD workload ratio	1.3	0.74	0	3.5
PT workload ratio	1.3	1.5	0.3	6.5
OT workload ratio	2.7	1.3	0	5.3
SLP workload ratio	0.9	0.49	0	2.0
RN workload	137	57	49	300
Diversity of allied health professions	4.8	0.44	2	5.0
Number of new graduate therapists	2.0	1.9	0	8
Ratio Pro. Therapists	0.84	0.08	0.6	0.98
Tuition ($)	10,480	10,037	0	74,071
Diversity of acute care specialists	6.3	1.2	3	7
Nurse specialist in stroke (% yes)	52%			
PT specialist in stroke (% yes)	53%			
Physical Facilities				
Rehab equipment types	8.7	1.7	4	11
Use of prefab AFOs (% yes)	51%			
Simulated home environment (% yes)	34%			
Adaptive kitchen (% yes)	81%			
Coordination of Care				
Number of disciplines at rounds	8.6	2.0	2	12
Uses stroke guidelines (% yes)	33%			
Use of paid escort service for patient transport (% yes)	57%			
Treating therapist at rounds (% yes)	81%			
Hospital Characteristics				
Number rehabilitation training programs	3.4	1.3	0	6
Rehabilitation workload	3,287	1,645	562	6,149
Hospital bed total	688	314	187	1466
Number of stroke care settings	5.2	1.0	2	7
Number of post acute settings	3.4	0.91	1	5
Joint affiliations with academic medical center	88%			
VA home health (% yes)	77%			
Therapy on weekends (% yes)	33%			
Recent organizational change (% yes)	31%			
Outpatient travel <1 hour	26%			

Table 3.
Unadjusted site means (facility level means of 59 facilities).

	Mean of Means	SD of Means	Lowest Site Mean	Highest Site Mean
Functional Gain (FIM points)	22.7	6.1	11.0	35.8
LOS	32.1	11.1	17.9	68.4
Community Discharge	70%	0.2	14%	95%

stroke patients had the longest LOSs while the oldest and mildest stroke patients had the shortest LOSs.

The remaining covariates and structure variables will be presented separately, within the framework of each model. The following factors were important for the LOS model: functional gain, marital status, year of discharge, source of admission, the diversity of allied health personnel, and the availability of ankle/foot orthoses. Functional gain was positively associated with LOS. Being married, as expected, was associated with shorter LOSs. Year of discharge was negatively associated with LOS, as LOSs have been shortening of late. Source of admission (i.e., transfer from another facility) was positively associated with LOS. Since this variable represented whether or not the patient was transferred from another acute facility, these patients likely possess unique treatment challenges not captured by the admission severity score adjustment.

After controlling for patient level covariates and unique, unmeasured site effects (site as a classification variable in the proc mixed model), two structural variables were statistically significant in the LOS model. The diversity (PT+KT+OT+SLP+RT) of allied health professionals was associated with longer lengths of stay, as was the availability of prefabricated ankle/foot orthoses.

The following factors were important for the functional gain model: LOS, onset time, co-morbidity, treating therapist participating in rounds, and MD workload. LOS was positively related to functional gain. Onset time and co-morbidity (as measured by the Charlson Index) both exerted a negative effect on patient functional gains. Two structure variables were associated with patient functional gain after controlling for patient level covariates. If treating therapists participated in patient rounds, this characteristic was positively associated with increased patient functional gain. MD workload ratio was negatively associated with functional gain, hence, fewer physicians per workload was associated with higher patient functional gains. MD workload ratio was calculated by taking the net number of PM&RS physicians and dividing by the hospital-wide rehabilitation workload.

The following patient factors were important for community discharge: LOS, functional gain, marital sta-

Table 4.
Structural effects upon patient outcomes.

	Logged Length of Stay		Functional Gain		Community Discharge	
Patient Covariates	**Estimate**	**Pr>t**	**Estimate**	**Pr>t**	**Estimate**	**Pr>t**
Admission severity	0.01	0.0001	-0.43	0.0001	0.06	0.0001
Age*Severity	-0.16	0.0001	-12.00	0.0001	0.49	0.002
Loglos			5.26	0.0001	-0.41	0.0001
Functional Gain	0.007	0.0001			0.06	0.0001
Marital Status	-0.05	0.020			0.89	0.0001
Year of discharge	-0.14	0.0001			0.21	0.04
Source of admission	0.12	0.0001			-0.37	0.008
Onset (logged)			-1.82	0.0001		
Comorbidity (Charlson)			-1.15	0.0001		
Structure Variables						
Diversity of Allied Health Professionals	0.14	0.020				
Availability of Prefabricated ankle/foot Orthoses	0.19	0.001				
Treating Therapist=Rounding Therapist			3.3	0.03		
MD Workload Ratio			-2.00	0.02		

tus, year of discharge, and source of admission. LOS was negatively associated with community discharge. Functional gain was positively associated with community discharge. Being married was associated with higher community discharge rates. Year of discharge was positively associated with community discharge. Source of admission (i.e., transfer from another facility) was negatively associated with community discharge. No structure variables were significantly associated with community discharge rates after controlling for patient covariates.

DISCUSSION

Previous work indicates that approximately 20–25 percent of the variation in stroke patient outcomes of functional gain and LOS in rehabilitation bedservice units can be explained by patient level characteristics (14). An additional 6 percent to 13 percent of variation in these patient outcomes is attributed to the rehabilitation unit itself (14). This variation may represent structure and/or process effects. This study was an attempt to explain some or all of this "site" variation in outcomes by examining RBU structure in detail, and testing for its effects.

We examined a set of variables that were representative of four categories of key structural factors, including personnel, physical facilities, coordination of care, and hospital characteristics. We found that four of these variables representing personnel, physical facilities, and coordination of care were significantly associated with either LOS or patient functional gain. Specifically, the diversity of allied health professional staff (personnel) and the availability of ankle/foot orthoses (physical facilities) were both associated with increased LOS. Observing an increased LOS with greater diversity of professional staff is consistent with multidisciplinary coordination. That is, the more disciplines and staff involved in the care of the patient, the longer the treatment time may be (e.g., therapists may compete with one another for treatment times, and coordinating discharge planning will have increased opportunities for delay). Increased availability of prefabricated ankle/foot orthoses and increased LOS is less intuitive from a causal perspective but suggests that facilities providing more comprehensive services may take longer to provide the complete package of services. Further, this may represent a control mechanism to reduce LOSs caused by other unrelated factors.

In the functional gain modeling, if the treating therapist was also the therapist that went on rounds (coordination), patients on those units made greater functional gains. The explanation for this effect is both intuitive and logical. The therapist working with the patient on a daily basis will know the patient, their capacity, and their potential better than any other clinical decision-maker. Hence, their clinical judgement will be the best predictor of maximal patient gains and provide the best estimates of when the functioning of the patient has reached a plateau.

The second significant finding for the functional gain model identifies units with lower physician/workload ratios (personnel) as having increased patient functional gains. First thoughts would attribute this effect to high volume; however, workload by itself was not significant. Rather, this likely represents an effect of physician clinical expertise, in the same sense that cardiologist or surgeons who perform high volumes of a given procedure have better outcomes (16–18). Additionally, treatment units that use a large number of multidisciplinary providers of care may require fewer physicians per patient and produce higher functional gains for patients.

These findings and their interpretations are perhaps somewhat ambiguous taken from a single variable perspective. However, these structures as a group (diversity of allied health professionals, fewer physicians, rounding therapist is the treating therapist, and availability of prefabricated AFOs as a marker for comprehensive services) represent key attributes of optimal rehabilitation care. A diverse staff, experienced physicians, staff that are available to the treatment team, and comprehensive services may measure distinctly important resources for a successful rehabilitation unit. In particular, experienced physicians and staff availability to the treatment team seem to be important criteria for optimizing functional gain. If a longer LOS also confers functional or quality of life benefits not captured through functional gain, then diversity of staff and equipment resources may also be considered key attributes of more successful rehabilitative care.

Limitations

A major limitation of this study is the sample size of 59 rehabilitation units. Small sample sizes limit the number of independent variables for testing and also limit the analytic power to detect differences. Since we could not increase our sample size (our sample was the entire population), we were forced to make a choice between: 1)

testing fewer independent variables and limiting type I error (false positives), or 2) testing more variables and tolerating increased type I error. We chose the latter for four reasons. First, little is known about the variation in organizational structures in specialized rehabilitation units. Second, given the significant variation in unit level patient outcomes, we wanted to maximize the opportunities to explore potential sources of this variation. Third, we felt there would be greater benefit with an exploratory-based analytic approach through the identification of future research opportunities. Fourth, the data set used in this investigation is uniquely available within the VHA and might never be constructed using private sector providers. Therefore, we felt an "exploratory" analysis was the most prudent use of this limited resource. Due to this exploratory approach, type I error (false positives) must be considered as a source for potential spurious findings.

The second limitation, also involving small sample size, is increased type II error (false negatives). Although this error is typically not considered as serious as type I error (false positives), it is nonetheless of some concern in a study with a sample size of 59 units.

The third limitation of this study involves the analysis of counts in the survey data. For example, the number of different disciplines present at rounds is not a measure of staffing diversity at rounds. At best, the count in this example is a proxy for staffing diversity. Therefore, a count of four for one facility may not necessarily equal a count of four at another facility. An attempt to derive some measures using factor analysis was undertaken to address this limitation; however, no useful measure resulted.

The fourth limitation of this study is the extent to which the research findings can be generalized. This study sample consisted of VHA rehabilitation bedservice units only. These units tend to be: 1) associated with larger VHA inpatient facilities; 2) located in large urban settings; and, 3) associated with academic medical centers. As such, the results of this study may not be applicable to rehabilitation units with differing characteristics.

The final limitation is the cross-sectional design of the surveys and the 2-year sample of patient outcomes. Although the cross-sectional surveys were completed roughly at the midpoint of the patient sample, the inferential associations become more difficult as the distance of the dependent observations increase from the survey collection time point.

CONCLUSIONS

Consistent with other studies in rehabilitation delivery, this investigation has found that organizational structure of rehabilitation care is associated with stroke patient outcomes. The findings for the individual variables in this study may describe, in combination, the key attributes of a comprehensive rehabilitation delivery mechanism (i.e., a stroke unit) that has been identified in the literature to exert significant positive effects on patient outcomes. The individual variables identified in this study, namely, diverse multidisciplinary staff, expert physician leadership, staff participation in team care, and richer rehabilitation equipment resources, may represent the distinct aspects of a successful, comprehensive rehabilitation unit.

REFERENCES

1. Ottenbacher K.J, Jannell S. The results of clinical trials in stroke rehabilitation research. Arch Neurol 1993;50:37–44.
2. Langhorne P, Williams B O, Gilchrist W, Howie K. Do stroke units save lives? Lancet 1993;342(8868):395–8.
3. Jorgensen HS, Kammersgaard LP, Nakayama H, Rasschou HO, Larsen K, Hubbe P, and Olsen TS. Treatment and rehabilitation on a stroke unit improves 5-year survival. Stroke 1999;30:930–3.
4. Ronning OM, Buldvog B. Stroke units versus general medical wards: Twelve- and eighteen-month survival. Stroke 1998;29:58–62.
5. Indredavik B, Bakke F, Slordahl SA, Rokseth R, Haheim LL. Stroke unit treatment. Stroke 1999;30:1524–7.
6. Indredavik B, Bakke F, Slordahl SA, Rokseth R, Haheim LL. Stroke unit treatment improves long-term quality of life. Stroke 1998;29:895–9.
7. Evans R L, Connis RT, Hendricks RD, Haselkorn JK. Multidisciplinary rehabilitation versus medical care: a meta-analysis. Soc Sci Med 1995;40(12, June):1699–1706.
8. Stevens RS, Isaacs B. Stroke rehabilitation unites in the United Kingdom. Health Trends 1984 Aug;16(3:61–3.
9. Kramer AM, Steiner JF, Schlenker RE, Eilertsen TB, Hrincevich CA, Tropea D, Ahmad L, Eckhoff DG. Outcomes and costs after hip fracture and stroke: A comparison of rehabilitation settings. JAMA 1997;277:396–404.
10. Indredavik B, Bakke R, Slordahl SA, Rokseth R, Haheim LL. Treatment in a combined acute and rehabilitation stroke unit. Which aspects are most important. Stroke 1999;30:917–23.
11. Donabedian, A. Explorations in quality assessment and monitoring. Vol I. The definition of quality and approaches to its assessment. Ann Arbor (MI): Health Administration Press; 1980.
12. Hoenig H, Sloane R, Horner R, Zolkewitz M, Duncan P, Hamilton B. A taxonomy for classification of stroke rehabilitation. In press, Arch Phys Med Rehabil 2000;81(7).
13. Veterans Administration Uniform Data System for Medical Rehabilitation (VA-UDS) [database]. Derived from the national-

based Uniform Data System for Medical Rehabilitation, Buffalo, NY. Rehabilitation Services Research and Development unit, Durham, NC.

14. Reker DM, O'Donnell JC, Hamilton, BB. Stroke rehabilitation outcome variation in Veterans Affairs rehabilitation units: Accounting for case-mix. Arch Phys Med Rehabil 1998;79:751–7.
15. Fink A, Kosecoff J, Chassin M, Brook RH. Consensus methods: characteristics and guidelines for use. Am J Public Health 1984(Sep);74(9):979/N83.
16. Showstack JA, Rosenfeld KE, Garnick DW, Luft HS, Schaffarzick RW, Fowles J. Association of volume with outcome of coronary artery bypass graft surgery. Scheduled vs nonscheduled operations. JAMA 1987;257:785–9.
17. Hannan EL, Siu AL, Kumar D, Kilburn H, Chassin MR. The decline in coronary artery bypass graft surgery mortality in New York State. The role of surgeon volume. JAMA 1995;273:209–13.
18. Hannan EL, Racz M, Kavey RE, Quagebeur JM, Williams R. Pediatric cardiac surgery: the effect of hospital and surgeon volume on in-hospital mortality. Pediatrics 1998;101:963–9.

Submitted for publication October 19, 1999. Accepted in revised form January 13, 2000.