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Research Article

# Association of Physical Functioning with Same-Hospital Readmission After Stroke

## ABSTRACT

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**Objective:** Readmission after hospitalization for stroke is an important outcome. We sought to document the frequency of same-hospital readmission and to determine the relative value of physical functioning as a predictor of the outcome.

**Design:** Consenting patients ($n = 228$) who were admitted for ischemic stroke were characterized according to demographics, stroke severity, and self-reported prestroke and postadmission physical functioning. The hospital's administrative database was used to track readmissions during the year after index hospitalization.

**Results:** Same-hospital readmissions were experienced by 37.3% of the patients. The readmissions usually occurred within 100 days of discharge. The most common readmission diagnosis was stroke (14.1%). Lower prestroke and postadmission physical functioning (as reflected by dichotomous Barthel index scores) were weak but significant predictors of readmission ($r = -0.165$ and $-0.268$, respectively). Regression analysis showed that once postadmission physical functioning was accounted for, neither prestroke functioning nor any other measured variable added to the explanation of same-hospital readmission.

**Conclusion:** The importance of physical functioning goes beyond rehabilitation. It is a potentially modifiable variable with implications for readmission.

**Key Words:** Stroke, Readmission, Self-Reported Function

Regardless of its provocation, hospital readmission is an important outcome variable that has not been adequately documented or explained.[1] The proportion of patients reported to be readmitted after hospitalization for stroke is notable but varies considerably, depending on the strata of patients described and the time frame considered.[2–8] Tu and Gong[8] reported that 9.9% of patients discharged from Ontario hospitals in 1998 were readmitted with another stroke within a year. Ottenbacher et al.[5,6] noted that about 18.0% of the patients discharged from inpatient rehabilitation facilities were readmitted to the hospital within 80–180 days of discharge. Claesson et al.,[3,4] whose samples were limited to patients who were at least 70 yrs old and discharged home, found between 44% and 51% to be readmitted to the hospital within a year. These highly disparate readmission rates provide little in the way of a benchmark for program evaluation. As a step toward reducing readmissions, researchers have attempted to identify variables that are responsible for or related to readmission. Recurrent stroke, stroke complications, and cardiovascular disease seem to be the most common reasons for readmission.[3,7] Age, marital status, rehabilitation length of stay, and functional independence during inpatient rehabilitation have been identified as related (either in bivariate or multivariate analyses) to readmission. As far as we are aware, physical functioning before and during acute hospitalization has not been examined as a predictor of readmission. Given the resources invested in poststroke rehabilitation, the relative importance of physical functioning as a predictor of readmission needs further examination. The purposes of this study of patients surviving index hospitalization for stroke were to: (1) document same-hospital readmissions during the subsequent year and to (2) describe the relative value of physical functioning as a predictor of readmission.

## METHODS

*Subjects.* This study was approved by the Institutional Review Committee of Hartford Hospital. Patients were eligible to participate if admitted with an acute ischemic stroke (confirmed by neuroimaging) between March 2000 and June 2001. There were 355 such patients. Of these, nine were excluded because they lacked admission National Institutes of Health Stroke Scale scores. A further 16 were excluded because they died during admission. A total of 102 were excluded because they declined to consent or because their cognitive or communicative status precluded provision of informed consent or accurate information about preadmission or postadmission physical functioning. The final sample, therefore, consisted of 228 of the eligible patients (69.0%). Selected characteristics of the subjects are summarized in Table 1. Most were elderly (mean age, 70.6 yrs) but functionally independent before their strokes, which were primarily mild. Co-morbidities were common among the patients, but only hypertension was present in the majority. Nine (3.9%) were treated with thrombolytics.

*Procedures.* After admission, the severity of each subject's stroke was rated by a trained neurology resident using the National Institutes of Health Stroke Scale. The reliability and validity of the National Institutes of Health Stroke Scale is well established.[9,10] After subjects' first therapy visits (usually within 48 hrs of admission), a trained research nurse interviewed them to determine their self-reported prestroke and poststroke independence in physical activities of daily living. The 20-point version of the Barthel index was used for this purpose.[11] Previous research has confirmed the reliability and validity of Barthel index scores thus obtained.[12–14] Co-morbidities were documented on the basis of the information recorded in each patient's chart. Readmissions and the diagnostic-related group associated with each readmission were determined using the hospital's administrative database.

*Analysis.* All statistical analysis was performed using SPSS 10.0 (SPSS, Chicago, IL). After the calculation of descriptive statistics, Barthel index scores and length of stay were dichotomized on the basis of their distribution or receiver operation curve analysis. Thereafter, the production of survival curves, the relationships between independent variables and readmission, were determined using special cases of the Pearson product moment correlation (i.e., point-biserial and phi). Finally, forward logistic regression analysis was conducted to establish the set of independent variables that best predicted readmission. Only variables that were significant ($P < 0.05$) bivariate predictors of readmission were entered into the analysis.

## RESULTS

Independent variables are summarized in Table 1. More than a third (37.3%) of the participating patients experienced at least one same-hospital readmission. As can be seen in the survival plots (Figs. 1 and 2), first readmissions were more common during the first 100 days after discharge but occurred throughout the 12-mo follow-up period. The number of readmissions experienced by individual patients ranged from one to six and is summarized in Table 2. The diagnostic-related group to which patients were assigned on their first readmission is presented in Table 3. The most common readmission diagnostic-related group was diagnostic-related group 14 (stroke), but potential complications of stroke (e.g., diagnostic-related group 79: respira-

**TABLE 1**
*Statistics relevant to the relationship between selected variables and hospital readmission among 228 patients with acute ischemic stroke*

| Continuous Variables | Not Readmitted, Mean (SD) | Readmitted, Mean (SD) | Point-Biserial (*P*) | Odds Ratio (95% CI) |
|---|---|---|---|---|
| Age, yrs | 70.4 (16.1) | 74.0 (13.3) | 0.113 (0.089) | 1.016 (0.997–1.035) |
| Length of stay, days | 5.0 (3.9) | 6.6 (4.9) | 0.176 (0.008) | 1.088 (1.018–1.163) |
| NIHSS score | 5.1 (5.1) | 6.3 (6.0) | 0.109 (0.099) | 1.041 (0.992–1.092) |
| Prestroke Barthel | 19.5 (1.7) | 18.7 (3.1) | −0.171 (0.010) | 0.858 (0.755–0.974) |
| Postadmission Barthel | 11.3 (6.8) | 7.8 (6.6) | −0.245 (0.001) | 0.927 (0.889–0.966) |

| Categorical Variables | Not Readmitted (*n*) | Readmitted (*n*) | Phi (*P*) | Odds Ratio (95% CI) |
|---|---|---|---|---|
| Sex, male/female | 72/71 | 40/45 | 0.032 (0.633) | 1.141 (0.666–1.953) |
| Race, white/nonwhite | 124/19 | 71/14 | −0.044 (0.511) | 0.777 (0.367–1.644) |
| Length of stay in days, ≤4/>4 | 85/58 | 34/51 | 0.188 (0.004) | 2.198 (1.271–3.801) |
| Discharged, home/elsewhere | 73/70 | 53/32 | −0.110 (0.098) | 0.630 (0.364–1.089) |
| History of stroke, −/+ | 115/28 | 62/23 | 0.087 (0.192) | 1.524 (0.810–2.867) |
| History of hypertension, −/+ | 51/92 | 20/65 | 0.127 (0.056) | 1.802 (0.982–3.305) |
| History of heart disease, −/+ | 88/55 | 46/39 | 0.073 (0.273) | 1.356 (0.788–2.336) |
| History of diabetes, −/+ | 115/28 | 58/27 | 0.138 (0.038) | 1.912 (1.033–3.539) |
| History of cancer, −/+ | 119/24 | 69/16 | 0.026 (0.697) | 1.150 (0.572–2.312) |
| Prestroke Barthel, <20/20 | 25/118 | 27/58 | −0.165 (0.013) | 0.455 (0.243–0.853) |
| Postadmission Barthel, ≤10/>10 | 58/85 | 58/27 | −0.268 (0.001) | 0.318 (0.180–0.559) |

NIHSS, National Institutes of Health Stroke Scale.

tory infection) and cardiovascular diagnoses were also culpable.

Bivariate correlations between independent variables and readmission and odds ratios are presented in Table 1. Whether characterized using actual Barthel index scores or dichotomized Barthel index scores, prestroke and postadmission physical functioning were correlated significantly with readmission. Specifically, patients who were functioning less independently were more likely to be readmitted. A patient with total physical independence before stroke (as reflected by a Barthel index score of 20) was only 45.5% as likely to be readmitted as a patient with any dependence (as reflected by a Barthel index score of <20). Similarly, a patient with a postadmission Barthel index score of >10 was only 31.8% as likely to be readmitted as a patient with a Barthel index score of ≤10. The survival plots show the disparities in readmissions over time for patients in the dichotomous function-

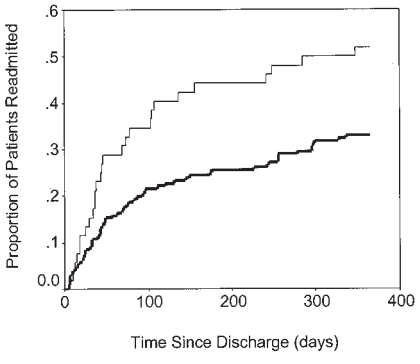


**Figure 1:** Survival plot illustrating the proportion of patients readmitted who had dichotomous prestroke Barthel index scores of <20 (*thin top line*) *vs.* 20 (*bold bottom line*).

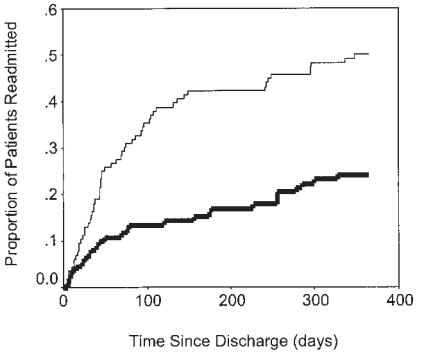


**Figure 2:** Survival plot illustrating the proportion of patients readmitted who had dichotomous postadmission Barthel index scores of ≤10 (*thin top line*) *vs.* >10 (*bold bottom line*).

**TABLE 2**
*Hospital readmissions experienced by 228 patients hospitalized for acute ischemic stroke*

| No. of Readmissions | Patients, *n* | Patients, % |
|---|---|---|
| 0 | 143 | 62.7 |
| 1 | 52 | 22.8 |
| 2 | 18 | 7.9 |
| 3 | 13 | 5.7 |
| 4 | 1 | 0.4 |
| 6 | 1 | 0.4 |

**TABLE 3**
*Diagnostic-related groups (DRGs) assigned to two or more patients at first readmission*

| DRG No. | DRG Description | Frequency | Percentage |
|---|---|---|---|
| 14 | Specific cerebrovascular disorders except TIA | 12 | 14.1 |
| 79 | Respiratory infections and inflammations (age, >17 yrs) with complications | 7 | 8.2 |
| 320 | Kidney and urinary tract infections (age, >17 yrs) with complications | 5 | 5.9 |
| 127 | Heart failure and shock | 4 | 4.7 |
| 116 | Other permanent cardiac pacemaker implant or PTCA with coronary artery stent | 4 | 4.7 |
| 5 | Extracranial vascular procedure | 3 | 3.5 |
| 138 | Cardiac arrhythmia and conduction disorders with complications | 3 | 3.5 |
| 130 | Peripheral vascular disorders with complications | 3 | 3.5 |
| 132 | Atherosclerosis with complications | 3 | 3.5 |
| 16 | Septicemia (age, >17 yrs) | 2 | 2.4 |
| 174 | Nonspecific cerebrovascular disorders with complications | 2 | 2.4 |
| 188 | Gastrointestinal hemorrhage with complications | 2 | 2.4 |
| 316 | Other digestive system diagnoses with complications (age, >17 yrs) | 2 | 2.4 |
| 416 | Renal failure | 2 | 2.4 |

TIA, transient ischemic attack; PTCA, percutaneous transluminal coronary angioplasty.

ing groups. Length of stay and a history of diabetes were the only other variables correlated significantly with readmission. Regression analysis showed that once the effect of postadmission function was considered, no other variable contributed significantly to the prediction of readmission.

## DISCUSSION

The first purpose of this study was to document same-hospital readmissions during the year after hospitalization for stroke. Although direct comparisons with other studies are fraught with confounders, our finding that 37.3% of patients were readmitted to our hospital over this time is close to the 32.5% same-hospital readmission rate we reported previously for a more comprehensive sample.[15] It is also within the range of values reported by others for readmissions not exclusive to a single hospital.[2–8] Notably, when relevant strata are selected, our readmission rates are lower than those reported by others. Specifically, when our patients who were ≥70 yrs of age and discharged home were selected, the 1-yr readmission rate was 31.5% (compared with the 44% and 51% rates of Claesson et al.[3,4]). When readmissions were selected on the basis of patients' experiencing another stroke, our rate was 5.3% (compared with the 9.9% rate of Tu and Gong[8]). Other than our focus on same-hospital readmissions, the reason for our lower readmission rate is uncertain. A reasonable explanation is that our sample was biased toward patients with less severe strokes. Indeed, the mean National Institutes of Health Stroke Scale scores of participating patients whose readmissions were tracked (5.6) and nonparticipating patients whose readmissions were not tracked (8.1) were significantly different ($t = 3.09$, $P = 0.002$). Although this fact should be acknowledged as a limitation, it must also be recognized that any study relying on self-report among patients with stroke will naturally exclude a proportion of otherwise eligible patients. Self-report information, whether about function or some other variable, can only be obtained from patients who are willing and able to provide it.

Although others have reported readmissions within specific time periods after stroke, we are unaware of literature addressing the time course of first readmissions. By presenting survival curves we provide information about such a time course. The curves show that same-hospital readmissions are more common early after admission for stroke but that they continue throughout the subsequent year. We, like Claesson et al.[3] and Sacco et al.[7] found that readmissions could most often be attributed to recurrent stroke, complications of stroke, or cardiovascular diagnoses. More than 60% of the readmissions in our study might be so attributed. These findings would seem to support increased efforts at secondary prevention.

Predictors of readmission have been described and functional independence has been identified as relevant.[5,6] The predictive value of functional independence, as far as we could tell from our literature search, has been established only for patients admitted for inpatient rehabilitation after discharge from the acute care hospital. Although our study included such patients, it also involved patients who went home directly from the hospital. Our study demonstrates that physical functioning, whether before or after admission for

stroke, is a predictor of readmission. Moreover, once postadmission physical functioning is accounted for, other variables (i.e., prestroke physical functioning, stroke severity, acute hospital length of stay, discharge location, previous stroke, or other comorbidities) do not add to the explanation of readmission status. Functional status, then, seems to matter. Further study is required to determine whether it is of causal importance or merely a covariate of some other cause.

## CONCLUSIONS

This study shows that same-hospital readmissions remain a prevalent untoward outcome of stroke. Many of the factors underlying readmission are potentially modifiable. Chief among these variables is physical functioning. Experimental trials are warranted that focus on activities (e.g., resistance, aerobic, and functional training) that might reduce the prevalence of stroke, decrease the rate of stroke recurrence, and prevent poststroke complications.

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