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ORIGINAL RESEARCH

Predictors of Discharge to Home after Thrombolytic Treatment in Right Hemisphere Infarct Patients

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Abstract

Background: The aim of the study was to assess the association between thrombolysis and length of hospital stay after right hemisphere (RH) infarct, and to identify which cognitive functions were predictive of discharge.

Methods: The study group consisted of 75 acute RH patients. Thirty-three patients had thrombolysis. Neuropsychological examinations were performed within 11 days of stroke onset. The cognitive predictors were visual neglect, visual memory, visual search and reasoning and visuoconstructive abilities. The outcome variable was time from stroke to discharge to home.

Results: Thrombolysis emerged as a statistically significant predictor of discharge time in patients with moderate/severe stroke (NIHSS $\geq$5). In the total series of patients and in patients with mild stroke (NIHSS $<$5), thrombolysis was not significantly associated with discharge time. Milder visuoconstructive defects shortened the hospital stay of the whole patient group and of patients with moderate/severe stroke. In all patient groups, independence in activities of daily living (ADL) was a significant single predictor of a shorter hospital stay. The best combination of predictors for discharge was independence in ADL in the total series of patients and in patients with mild stroke, and thrombolysis and independence in ADL in patients with moderate/severe stroke.

Conclusions: Thrombolytic treatment was a significant predictor of earlier discharge to home in patients with moderate/severe RH infarct, while cognitive functions had less predictive power.

Keywords: discharge, outcome, stroke, thrombolysis

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Introduction

Stroke is an important cause of death and severe disability in Western countries.[1,2] In Finland, approximately 14,000 people suffer a stroke each year. Stroke patients often spend long periods in hospital, and about half of all stroke survivors remain permanently disabled.[3] In many cases stroke patients' functional capacity is severely impaired by cognitive disorders.[4] Typical cognitive deficits after right hemisphere (RH) infarct include left-sided neglect, anosognosia, visuoconstructive and visuospatial disorders, and deficits in visual memory.[5–7] These cognitive deficits are known to lengthen the hospital stay.

Jehkonen et al[8] found that neglect, hemiparesis, size of infarction, unawareness of illness, female gender and poor verbal memory were statistically significant single predictors of a longer hospital stay. However, unawareness of illness was the only cognitive deficit included in the best combination of predictors, which was hemiparesis, unawareness of illness and the presence of a close person at home.[8] Frank et al[9] reported that the presence of a living partner was the strongest predictor of discharge to home after stroke. Friedman[10] found that patients with poor results in the line bisection test had poorer functional outcome as measured with the Barthel Index (BI),[11] walking speed and discharge residence than patients with normal results. Löfgren et al[12] examined 100 severely affected stroke patients and reported that the best model predicting patients' chances of returning home after rehabilitation were high postural stability score, low age, and absence of perceptual impairment. According to Ostwald et al[13] predictors of the decision to discharge stroke patients home include functional level, age, stroke severity and resultant impairments, comorbidities, risk factors, complications and the availability of a caregiver at home. None of the studies above examined the association between thrombolytic treatment and discharge time.

Thrombolytic treatment is the only approved pharmacological treatment for acute ischemic stroke.[14,15] There is conclusive evidence that thrombolytic treatment improves functional recovery after stroke.[16] Kwiatkowski et al[17] found that thrombolysis administered within 3 hours of the onset of symptoms improved recovery after acute ischemic stroke during a 12-month follow-up. Other clinical studies have also shown that thrombolysis is beneficial in patients with acute stroke.[18] However, no research has been carried out to explore the association between thrombolysis and length of hospital stay.

The aim of this study was to assess the associations between thrombolysis and length of hospital stay after RH infarct. A further concern was to establish whether specific cognitive functions, namely visual neglect, visual memory, visual search and reasoning, and visuoconstructive abilities, were predictive of discharge.

Patients and Methods

We screened 1458 consecutive stroke patients admitted to a university hospital as emergency cases and treated at the Department of Neurology between June, 2005 and June, 2008. Patients were excluded as follows: left hemisphere stroke (n = 276), brain stem or cerebellar stroke (n = 57), transient ischemic attack (n = 200), cerebral haemorrhage (n = 139), other neurological diagnosis (n = 137), previous stroke (n = 185), significant findings in computed tomography (CT) not related to acute stroke (n = 92), traumatic brain injury (n = 6), substance abuse (n = 21), psychiatric disorder (n = 20), age over 80 years (n = 144), left-handedness (n = 5), native language other than Finnish (n = 4), and unable to participate in neuropsychological examination (n = 95). The remaining study population consisted of 77 consecutive patients with an acute first ever RH infarct. Out of these 77 patients, 2 were omitted from further analysis due to missing data about discharge time. The final study group thus consisted of 75 RH infarct patients. Thirty-three patients (44%) had thrombolytic treatment. All the patients who participated in the study managed activities of daily living (ADL) independently before the onset of stroke. All participants gave their written informed consent. The study was approved by the Ethical Committee of the university hospital.

Neuropsychological and neurological examinations were carried out within 11 days of the onset of stroke. The neuropsychological examination was performed on average 4 days after onset (Md = 4.00; range = 1–11). Repeated neuropsychological examinations were not carried out during in-patient time. During their hospital stay all patients were treated according to standard procedures for stroke patients. The patients were divided into 2 groups according to the baseline sum score of

the National Institute of Health Stroke Scale (NIHSS)[19] using the median (=5) as cut-off score. NIHSS sum scores from 0 to 4 were scored as "0" (mild stroke) and NIHSS sum scores ≥5 were scored as "1" (moderate/severe stroke). As Ostwald et al[13] have reported, previous studies show that NIHSS scores <5 are predictive of discharge to home.

Neuropsychological Examination

The cognitive predictors examined were visual neglect, immediate visual memory, visual search and reasoning, and visuoconstructive abilities. Visual neglect was assessed with 6 conventional subtests of the Behavioural Inattention Test (BIT).[20,21] Patients scoring below the cut-off in at least 2 of the BIT subtests were considered to have visual neglect. Visual memory was assessed with the Visual Reproduction subtest (range: 0–41) of the Wechsler Memory Scale Revised (WMS-R).[22] Visual search and reasoning and visuoconstructive abilities were assessed with the Picture Completion (range: 0–22) and the Block Design (range: 0–51) subtests of the Wechsler Adult Intelligence Scale Revised (WAIS-R),[23] respectively. Raw scores of the Wechsler subtests[22,23] were used. Some of the patients were transferred from the acute neurological ward to public health centres in the hospital district, and therefore the patients were discharged either directly from the university hospital neurological ward or from public health centres. The outcome variable was time in days from the onset of stroke to discharge to home either from the neurological ward or from public health centres.

Neurological and Neuroradiological Examinations

Severity of stroke was first evaluated upon admission to the emergency department by a neurologist using NIHSS (range: 0–34). Hemianopia was scored as absent (0) or present (1). Hemiparesis was scored for leg and arm separately on a scale from 0 (=normal) to 4 (=severe), and these scores were summed to give a range from 0 to 8. The neurological examination on the neurological ward was performed by a neurologist on the same (±1) day as the neuropsychological examination. Stroke severity was evaluated with NIHSS and basic ADL was assessed with the BI (range: 0–100). All patients had CT of the brain to verify RH infarct.

Statistical Analyses

Since some of the continuous variables were not normally distributed and the sample sizes were small, we chose to use median (Md) and quartiles (Q_1; Q_3) for all continuous variables. To find out whether the associations between discharge time and predictors were similar in patients with mild vs. moderate/severe stroke, the patients were divided into 2 groups (mild vs. moderate/severe stroke) according to their baseline NIHSS sum score using the median (=5) as cut-off score. To test the differences between the mild and moderate/severe stroke groups, Mann-Whitney U tests were used for continuous variables, and χ^2-test or Fisher's exact tests for categorical variables.

Cox regression analyses were used to determine which variables were associated with discharge time. Analyses were done for the whole sample and separately for the mild and moderate/severe stroke groups. The outcome variable was time from stroke to discharge to home in days. The predictors were thrombolysis, visual neglect, immediate visual memory, visual search and reasoning, visuoconstructive abilities, basic ADL (BI sum score), age, gender, education in years and presence of a relative at home. Presence of thrombolysis, visual neglect, hemianopia, hemiparesis and relative at home were scored as "1" and absence of thrombolysis, visual neglect, hemianopia, hemiparesis and relative at home as "0". The hemiparesis cut-off score was 1. First, the predictive significance of each variable was determined separately. Then the predictors for multivariate analyses were selected on the basis of the univariate analyses; variables with a *P*-value lower than 0.1 in univariate analyses were used. The best combination of predictors was then computed separately for total series of patients, patients with mild stroke and patients with moderate/severe stroke using the forward stepwise Cox model (probability of *F* to enter = 0.05 and probability of *F* to remove = 0.10). *P*-values ≤ 0.05 were considered statistically significant, but because of the small sample size *P*-values between 0.05 and 0.1 are reported as borderline significant. The statistical analyses were performed using SPSS/Win version 15.0 Software.

Results

Patients' clinical and demographic characteristics and comparisons between the 2 patient groups are shown

Table 1. Patients' demographic and clinical characteristics: whole sample and patients with mild and moderate/severe stroke.

Variables	Total series	Subgroups according to stroke severity		*P*-value
		Mild	Moderate/ severe	
Number of patients	75	37	38	
Female gender (%)	26 (34.7)	13 (35.1)	13 (34.2)	0.933*
Age: Md (Q_1; Q_3)	62.0 (56.0; 71.0)	62.0 (57.0; 71.0)	62.0 (54.0; 70.5)	0.345**
Education (years): Md (Q_1; Q_3)	10 (8.0; 11.0)[a]	9.8 (8.0; 12.0)[b]	10.0 (8.0; 11.0)[b]	0.512**
Relative at home (%)	58 (77.3)	28 (75.7)	30 (78.9)	0.735*
Thrombolysis: n (%)	33 (44.0)	14 (37.8)	19 (50.0)	0.289*
Neglect (BITC): present (%)	15 (20)[c]	7 (20.0)[a]	8 (21.6)[b]	0.866*
Hemiparesis: present (%)	33 (44.0)[d]	12 (37.5)[e]	21 (61.8)[f]	0.049*
Hemianopia: present (%)	2 (2.7)[d]	0 (0.0)[e]	2 (5.9)[f]	0.493***
Baseline stroke severity (NIHSS): Md (Q_1; Q_3)[1]	5.0 (3.0; 7.0)	3.0 (1.0; 4.0)	7.0 (6.0; 10.0)	<0.001**
Stroke severity on ward (NIHSS): Md (Q_1; Q_3)[2]	2.0 (0.0; 5.5)[g]	1.0 (0.0; 3.0)[h]	3.0 (1.0; 8.0)[f]	0.009**
Basic ADL (BI): Md (Q_1; Q_3)	95.0 (65.0; 100.0)[i]	100.0 (95.0; 100.0)[h]	85.0 (52.5; 97.5)[e]	0.001**
Visual memory (imm.) (WMS-R): Md (Q_1; Q_3)	32.0 (26.0; 37.0)	33 (26.0; 36.5)	30.0 (26.0; 37.0)	0.799**
Visual search and reasoning (WAIS-R): Md (Q_1; Q_3)	14.0 (10.0; 17.0)[b]	14.0 (10.0; 17.0)	14.0 (8.5; 16.5)[b]	0.536**
Visuoconstructive abilities (WAIS-R): Md (Q_1; Q_3)	18.0 (10.0; 27.0)	19.0 (11.0; 26.5)	17.5 (6.0; 27.3)	0.648**

Notes: [1]NIHSS sum score evaluated at the time of admission to emergency department; [2]NIHSS sum score evaluated at the neurological ward; [a]2 cases missing; [b]1 case missing; [c]3 cases missing; [d]9 cases missing; [e]5 cases missing; [f]4 cases missing; [g]10 cases missing; [h]6 cases missing; [i]11 cases missing; * = χ^2-test; ** = Mann-Whitney U test; *** = Fisher's exact test.
Abbreviations: Md, median; Q_1, lower quartile; Q_3, upper quartile; BITC, conventional subtests of the Behavioural Inattention Test; patients scoring below the cut-off in at least 2 of the BITC subtests were considered to have neglect; NIHSS, National Institute of Health Stroke Scale; ADL, activities of daily living; BI, Barthel Index; imm, immediate; WMS-R, Wechsler Memory Scale—Revised; WAIS-R, Wechsler Adult Intelligence Scale—Revised.

in Table 1. The groups differed significantly in hemiparesis, baseline stroke severity, stroke severity at neurological ward and basic ADL. More patients had hemiparesis in the moderate/severe stroke group than in the mild stroke group. Patients with mild stroke were more independent in basic ADL than patients with moderate/severe stroke. No statistical differences were found between the groups in gender, age, education, presence of relative at home, number of thrombolytic patients, presence of visual neglect or hemianopia, and other cognitive defects (immediate visual memory, visual search and reasoning, and visuoconstructive defects).

All patients returned home either from the acute neurological ward or from a rehabilitation ward. The discharge time ranged from 3 to 48 days (Md = 6.0) in thrombolytic patients, and from 1 to 184 days (Md = 7.0) in non-thrombolytic patients. The median discharge time in the group of patients with mild stroke was 6.0 days (range: 1–28) and in the group of patients with moderate/severe stroke 12.0 days (range: 3–184). The longest discharge times (>60 days) were found in the group of non-thrombolytic patients, and there were also more non-thrombolytic patients (6) than thrombolytic patients (2) with a discharge time of over 1 month. Table 2 describes the breakdown of discharge times in these groups.

Table 3 shows the significance of each predictor in the patient groups. In the total series of patients thrombolysis did not show a statistically significant association with discharge time. Independence in ADL, better immediate visual memory, milder defects in visual search and reasoning, and milder visuoconstructive defects shortened the hospital stay in the whole patient group. Moreover, visual neglect had borderline significance as a single predictor. Patients with neglect had a longer hospital stay.

In the group of patients with mild stroke, thrombolysis was not significantly associated with discharge time. However, basic ADL predicted the outcome in patients

Table 2. Discharge time in days in the groups of thrombolytic (T+) and non-thrombolytic (T–) patients in total series of patients and in the subgroups (mild vs. moderate/severe stroke) of patients.

Discharge time (days)	Total series		Mild stroke		Moderate/severe stroke	
	T+: n (%)	T–: n (%)	T+: n (%)	T–: n (%)	T+: n (%)	T–: n (%)
<10	22 (66.7)	24 (57.1)	10 (71.4)	21 (91.3)	12 (63.2)	3 (15.8)
10–30	9 (27.3)	9 (21.4)	4 (28.6)	2 (8.7)	5 (26.3)	7 (36.8)
31–60	2 (6.1)	6 (14.3)	0 (0.0)	0 (0.0)	2 (10.5)	6 (31.6)
>60	0 (0.0)	3 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)	3 (15.8)

with mild stroke, and independence in ADL shortened the hospitalization period. Moreover, immediate visual memory had borderline significance as a predictor of discharge time and shortened the hospital stay. Presence of a relative at home was not a significant predictor of discharge in any of the patient groups. In the group of patients with moderate/severe stroke, thrombolysis, independence in ADL, milder visuoconstructive defects and higher education shortened the hospital stay. Immediate visual memory had borderline significance in predicting discharge time. Better immediate visual memory shortened the hospital stay.

We also identified the best combination of predictors for each patient group (total series, mild stroke and moderate/severe stroke; Table 4). For the total series of patients, basic ADL, visual neglect, immediate visual memory, visual search and reasoning and visuoconstructive abilities were entered in the multivariate model as possible predictors. For the patient group with mild stroke, basic ADL and immediate visual memory were entered in the multivariate analysis as possible predictors. For patients with moderate/severe stroke, education, thrombolysis, basic ADL, immediate visual memory and visuoconstructive abilities were entered as possible predictors. In the total series of patients and in the mild stroke group, only basic ADL emerged as a statistically significant predictor. Independence in ADL shortened the hospital stay. In the group of patients with moderate/severe stroke, basic ADL and thrombolysis were statistically significant predictors for discharge to home. Independence in ADL and thrombolytic treatment shortened the discharge time.

Discussion

The aim of our study was to explore the association between thrombolytic treatment and discharge time after RH stroke. No earlier studies have explored the association between thrombolysis and length of hospital stay. Earlier evidence suggests that cognitive deficits after RH stroke lengthen the hospital stay.[8,10,12,13] In this study we were particularly interested in thrombolytic treatment and cognitive defects associated with RH stroke and their predictive value of discharge time. According to our results thrombolytic treatment was a significant predictor which shortened the hospital stay of patients with moderate/severe stroke, but it was not significantly associated with discharge time in patients with mild stroke. In the whole patient group thrombolysis did not show a statistically significant association with discharge time, but the longest discharge times (>30 days) were found in the group of non-thrombolytic patients.

Basic ADL emerged as a significant single predictor in each group of patients, indicating that independence in ADL shortened the hospitalization time. This is in line with a previous study.[9] Visuoconstructive defects and lower education predicted longer hospital stay in the group of patients with moderate/severe stroke. Moreover, immediate visual memory had borderline significance as a predictor of discharge time in both subgroups (mild stroke and moderate/severe stroke) of patients. Better immediate visual memory shortened the hospitalization time. In the total series of patients, independence in ADL, better immediate visual memory, milder defects in visual search and reasoning and milder visuoconstructive defects were statistically significant single predictors of shorter hospital stay. Visual neglect had borderline significance as a single predictor in the total series of patients, indicating that patients with neglect had a longer discharge time.

In the multivariate analyses, none of the cognitive predictors were included in the best combination of predictors, which was basic ADL in the total series of patients and in the group of mild stroke patients, and thrombolysis and basic ADL in the group of moderate/severe stroke patients. Thrombolytic

Table 3. Prediction of discharge to home with each predictor separately and in the total series of patients vs. in the two subgroups (mild vs. moderate/severe stroke) of patients.

Predictor	Total series			Mild stroke			Moderate/severe stroke		
	HR	95% CI for HR	*P*-value	HR	95% CI for HR	*P*-value	HR	95% CI for HR	*P*-value
Age	0.99	(0.97, 1.01)	0.362	0.98	(0.95, 1.01)	0.194	0.99	(0.97, 1.01)	0.355
Gender	0.78	(0.48, 1.27)	0.318	0.62	(0.30, 1.29)	0.201	0.73	(0.36, 1.48)	0.390
Education (years)	1.07	(0.98, 1.17)	0.139	0.96	(0.85, 1.07)	0.441	1.18	(1.00, 1.40)	0.050
Relative at home	1.30	(0.75, 2.24)	0.345	1.31	(0.61, 2.81)	0.484	1.36	(0.62, 3.01)	0.447
Thrombolysis	1.41	(0.88, 2.27)	0.157	0.60	(0.30, 1.18)	0.138	2.74	(1.36, 5.51)	0.005
Basic ADL (BI)	1.03	(1.02, 1.04)	<0.001	1.05	(1.02, 1.08)	0.002	1.03	(1.01, 1.04)	0.001
Neglect (BITC)	0.60	(0.33, 1.07)	0.080	0.53	(0.22, 1.24)	0.141	0.58	(0.25, 1.33)	0.199
Visual memory (imm.) (WMS-R)	1.04	(1.01, 1.08)	0.016	1.06	(1.00, 1.12)	0.052	1.04	(0.99, 1.09)	0.090
Defects in visual search and reasoning (WAIS-R)	1.06	(1.00, 1.12)	0.038	1.05	(0.97, 1.13)	0.204	1.06	(0.98, 1.14)	0.156
Visuoconstructive defects (WAIS-R)	1.04	(1.02, 1.07)	0.002	1.01	(0.97, 1.06)	0.607	1.06	(1.02, 1.10)	0.002

Abbreviations: HR, hazard rate; CI, confidence interval; BITC, conventional subtests of the Behavioural Inattention Test; patients scoring below the cut-off in at least 2 of the BITC subtests were considered to have neglect; NIHSS, National Institute of Health Stroke Scale; ADL, activities of daily living; BI, Barthel Index; imm, immediate; WMS-R, Wechsler Memory Scale—Revised; WAIS-R, Wechsler Adult Intelligence Scale—Revised

Table 4. Statistically significant predictors of discharge to home from multivariate analyses (forward stepwise method) in the total series of patients, in the group of mild stroke and in the group of moderate/severe stroke.

Predictors	HR	95% CI for HR	*P*-value
a) Total series			
Basic ADL (BI)	1.03	(1.02, 1.04)	<0.001
b) Mild stroke			
Basic ADL (BI)	1.05	(1.02, 1.08)	0.002
c) Moderate/severe stroke			
Thrombolysis	2.75	(1.21, 6.24)	0.016
Basic ADL (BI)	1.03	(1.01, 1.04)	0.002

treatment predicted shorter discharge time in patients with moderate/severe RH infarct, and independence in ADL predicted shorter discharge time in all patient groups. Our results suggest that common cognitive defects associated with RH stroke were not significant predictors of discharge time except for visuoconstructive defects, which had predictive value as a single predictor in the whole patient group and in patients with moderate/severe stroke. This is in line with the results of a previous study.[8] However, in our study immediate visual memory, defects in visual search and reasoning and visuoconstructive defects were statistically significant single predictors in the whole patient group, but they were not included in the best combination of predictors. In some previous studies[8,10,24] visual neglect emerged as a significant predictor of discharge time. In our study, visual neglect did not show a statistically significant association with discharge time, except in the total series of patients, where it had borderline significance. This may be due to the relatively small number of neglect patients in our sample. We also found that age was not a significant predictor of discharge time, as has been reported earlier.[9,25] However, Ostwald et al[13] reported that age was among the factors identified as predictors of discharge to home in stroke patients. Interestingly, in our study presence of a relative at home was not a significant predictor of discharge, which is not in line with previous studies.[8,9,13]

Returning home is one of the most important aims of stroke patients admitted to hospital.[9] As Jehkonen et al[8] have suggested, the time from stroke to discharge to home may be affected by factors unrelated to the patient's condition. For example, the rehabilitation wards to which the patients were transferred may have different discharge policies than the acute neurological ward. On the other hand, discharge time is a realistic outcome measure in

that patients would probably not be kept on wards for any longer than is necessary for sufficient recovery. The time from stroke to discharge can also be considered an objective outcome measure, because it is based on a professional assessment of the patient's condition. To conclude, thrombolytic treatment seemed to be especially beneficial for patients with moderate/severe RH baseline stroke, since it shortened the discharge time in this subgroup of patients. In this study, we have focused exclusively on RH patients, but our ongoing investigations also include left hemisphere infarct patients so that the results can be generalized to the stroke population more widely.

Disclosure

This manuscript has been read and approved by all authors. This paper is unique and is not under consideration by any other publication and has not been published elsewhere. The authors and peer reviewers of this paper report no conflicts of interest. The authors confirm that they have permission to reproduce any copyrighted material.

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