Frontiers in Medicine and Health Research
An open access journal
eSciRes
FMHR-2-111
Research Article

Factors Predicting Discharge Disposition after Sub-acute Stroke Rehabilitation

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Abstract

A variety of factors influence discharge disposition post stroke, but the effects of many variables are still controversial and there is scarce information on part of the possible predictors. A better comprehension of the factors associated with discharge disposition may help to establish more realistic and tailored treatments, and a better preparation of the rehabilitants and significant others for the transition from hospital to community or institution. In this observational cohort study of 229 consecutive subacute stroke rehabilitants, 28.5% were discharged home without service, 37.1% with service and 34.5% were discharged to institutional care. The rehabilitants institutionalized were oldest, had the highest stroke and disease severity and disability, most comorbidities and the longest time from stroke onset to rehabilitation admission. Those discharged home without service were youngest, most often still working and they had the shortest length of stay, and the mildest stroke severity and disability. The subgroup discharged home with service had significantly higher functional improvement than those institutionalized despite equal length of rehabilitation in-stay. In bivariate analysis, a number of clinical, functional and demographic variables were associated with discharge disposition. In regression analysis, the most influential predictors for discharge disposition towards increasing support or institutionalization were higher age, lower admission FIM scores in sphincter control, locomotion and cognition, lower FIM gain during the rehabilitation in-stay, higher severity of neglect and acute phase dysphagia/ feeding tube.

Keywords: Discharge disposition; Inpatient; Rehabilitation; Stroke; Subacute

Abbreviations

FIM: Functional Independence Measure; DNR: Do Not Resuscitate; ICD-10: International Classification of Diseases 10th version; NIHSS: National Institutes of Health Stroke Scale; CBS: Catherine Bergego Scale; IQR: Interquartile range; SAH: Subarachnoid Hemorrhage; Cl: Confidence limits; OR: Odds Ratio

Introduction

Discharge planning after hospitalization of stroke survivors is a multidimensional process affecting millions of people around the world. Globally, roughly 14 to 17 million stroke events occur annually. Around 40 to 50% of acute stroke patients need multidisciplinary rehabilitation. According to clinical practice guidelines, post-stroke rehabilitation involves a multidisciplinary team and seeks to help rehabilitants to improve their functional performance, the ultimate goal being the best possible level of functioning and ability to participate in personal life and society. In addition, early community discharge is recommended when medically appropriate and when suitable community rehabilitation is available [1]. Home discharge and continued outpatient rehabilitation or therapy in a home-setting is the preferred goal for most rehabilitants as well [2]. A shorter hospital stay would decrease the costs, but necessitates care and service need evaluation that respects the prognosis for improvement [3]. A better understanding of factors associated with home discharge may lead to establishing more realistic goals, tailored rehabilitation treatments, and a better preparation of patients and informal caregivers for the transition back home [4].

Various clinical, functional, social, and demographic factors play a role in discharge planning after stroke [5] but the effects of many variables are controversial and there is scarce information on part of the possible predictors for discharge disposition [5,6]. Not only the level of clinical severity or functional ability but also the progress with rehabilitation may be of importance, but has not been studied sufficiently [5,7-9]. Stroke specific clinical and functional factors including dysphagia and incontinence in addition to potentially modifiable predictors [9] such as neglect [10] should be further explored. Many studies have investigated univariate associations, but multivariate analysis would be more beneficial to adjust for various confounding factors [4]. Also, research on a local scale is recommended as many factors such as geography, economy and culture may influence the optimal discharge destination of choice [5,11].

The objective of this study was to investigate in the Hospital District of Southwest Finland a variety of different clinical and functional variables including degree and rate of functional improvement and demographic and social factors that potentially influence discharge disposition after subacute inpatient stroke rehabilitation. For a more detailed analysis compared with previous studies, the rehabilitants were divided into three subgroups, those discharged to community either without or with social service and those institutionalized.

Background

On a university hospital inpatient rehabilitation ward, 229 consecutive stroke patients aged over 16 years were included in the study between August 2015 and March 2019. The patients were mostly referred to the neurological rehabilitation unit from the acute stroke unit of the same university hospital. Sometimes the patient had to wait after the acute stroke unit care on a general ward for stabilization of the medical condition before intensive rehabilitation or because of lack of capacity of the rehabilitation unit. Because of intensive program and high costs of multidisciplinary rehabilitation it is necessary to assess which patients are most suited for admittance to intensive rehabilitation ward and which patients would be better taken care of at home with possible outpatient therapies or in a skilled nursing facility [5]. For admission to our rehabilitation ward, patients had to be able to sit in a wheelchair for a minimum of 30 minutes.

A multidisciplinary team evaluation included assessments made by a neurologist, a physiotherapist, an occupational therapist, a neuropsychologist, a speech and language therapist, a social worker, a rehabilitation planner, rehabilitation nurses and when necessary, also other consultants. Intensive comprehensive inpatient rehabilitation program consisted of combined coordinated meetings with these rehabilitation specialists five days a week according to patients´ individual needs in addition to constant daily rehabilitative nursing.

Significant others, usually family members or relatives, sometimes a close friend were encouraged to participate in daily activities, in different therapy and social work sessions and in at least one meeting with the entire team to discuss the current medical and functional status of the rehabilitant and the future goals, care and rehabilitation plans, service needs, and discharge destination. The rehabilitation program usually included at least one home-training visit during a weekend accompanied by the significant other, who filled in a questionnaire about the rehabilitants capabilities and needs during the home stay. Before the first home-training visit, the rehabilitation planner together with some other members of the team visited the home or future residence to provide the rehabilitant, the significant others and the residential social service staff detailed counseling and recommendations on possible home modifications and assistive devices needed.

Patients and Methods

At discharge, the 229 rehabilitants were divided into three subgroups: firstly those discharged back home without any formal assistance but with possible outpatient rehabilitation recommendations (home without service), secondly those discharged home with the aid of social services in various activities of daily living or in transportation, transactions and running errands and possibly care and rehabilitation in a home-setting in addition to outpatient rehabilitation recommendations (home with service), and thirdly those institutionalized (change in living location towards increased support) which usually meant discharge to a residential health care center where the assisted living residence or other long-term facility was arranged locally; sometimes, however, the permanent facility was arranged directly from the rehabilitation ward. In some cases after continued care and rehabilitation in a health care center the rehabilitant might still be able to return home some weeks later with the aid of home modifications and services to support living at home.

Inclusion criteria of this study were first major stroke demanding inpatient rehabilitation after acute care and premorbid independent living. Exclusion criteria were current major medical, neurological or psychotic condition in addition to stroke (n=1), delay in admission to rehabilitation from stroke onset over one year (n=2), and medical reasons for interrupted rehabilitation (n=5).

Demographic variables

The demographic data including age at stroke onset, gender, living situation (cohabiting), educational level and working status (i.e. work or study) were gathered from the participants (Table 1).

Independent variables

The independent acute phase and admission variables possibly affecting discharge category included: type (infarction *vs.* hemorrhage) and location of lesion, stroke severity, ambulatory ability, presence and severity of paresis, neglect and aphasia, presence of apraxia, depression and dysphagia/ feeding tube, time from stroke onset, length of stay, DNR (do not resuscitate) decision, number of comorbidities, Charlson comorbidity index. In ordinal logistic regression analysis admission clinical and neurological data were used except for acute phase assessments for dysphagia and/or feeding tube and DNR decision in order to have sufficient amount of cases in every subgroup (Table 2).

Clinical data, e.g. ICD-10 diagnosis: I63 brain infarction, I61 intracerebral hemorrhage or I60 subarachnoid hemorrhage (all without intra-parenchymal hematoma), date of diagnosis, date of admission and discharge, initial neurological status and 24 hour NIHSS after possible thrombolysis and /or thrombectomy, comorbidities, DNR were collected from the hospital patient charts. The total number of comorbidities was counted, a procedure previously used to categorize comorbidities [12], and also the Charlson comorbidity index was calculated [13]. A neurologist assessed the neurological status and stroke severity using the National Institutes of Health Stroke Scale (NIHSS) score at admission. The presence and severity of neglect was assessed by an occupational therapist using the Catherine Bergego Scale (CBS). The presence of depression and apraxia were based on clinical judgement of the team.

All pairwise comparisons are Bonferroni corrected							
	Home without service	**Home with service**	**Institution**	**Group 1 *vs.* 2**	**Group 1 *vs.* 3**	**Group 2 *vs.* 3**	**Groups 1+2 *vs.* 3**
Variables	**Group 1 n=65**	**Group 2 n=85**	**Group 3 n=79**	**difference between medians (95% Cl), p**			
			Median (IQR, range)				
Age (years)	56.5 (50.2, 64.8; 24.3-73.2)	65.6 (55.3, 71.4; 16.3-83.6)	69.9 (60.2, 76.6; 38.2-83.4)	-7.3 (-11.0, -3.6), 0.002	-12.0 (-15.8, -8.2), 0.0004	4.8 (1.5, 8.1), 0.02	7.8 (4.7, 10.8) 0.0004
Education (years)	12.0 (9.0, 14.0; 6.0-25.0)	11.0 (9.0, 12.0; 6.0-20.0)	10.0 (8.0, 13.0; 6.0-22.0)	1 (0, 2), 0.25	1.5 (0, 3), 0.06	-0.5 (-1, 0), 1.0	-1 (-2, 0), 0.26
			N (%)				
Gender male	33 (50.8)	49 (57.6)	46 (58.2)				
Cohabiting	47 (72.3)	55 (64.7)	42 (53.2)				
Still working	39 (60.0)	30 (35.3)	16 (20.2)				
Cl = Confidence limits; IQR = Interquartile range							

Table 1: Demographic data of the rehabilitant subgroups (discharge dispositions). Difference on Hodges-Lehmann estimate for median difference.

	Home without service	Home with service	Institution	
Variables N (%):	Group 1 n= 65	Group 2 n= 85	Group 3 n= 79	p
Diagnosis: Infarction	39 (60.0)	61 (71.8)	52 (65.8)	0.002
ICH	17 (26.2)	23 (27.0)	26 (32.9)	
SAH	9 (13.8)	1 (1.2)	1 (1.3)	
Localization: right hemipheral	16 (24.6)	28 (32.9)	26 (32.9)	0.47
left hemispheral	28 (43.1)	41 (48.2)	35 (44.3)	
both sides	13 (20.0)	8 (9.4)	10 (12.7)	
posterior circulation	8 (12.3)	8 (9.4)	8 (10.1)	
FIM ambulatory/ sedentary/ both	60 (92.3)/ 4 (6.2)/ 1(1.5)	51 (60.0)/ 29 (34.1)/ 5 (5.9)	8 (10.1)/ 67 (84.8)/ 4 (5.1)	<0.0001
Falls or near falls during the stay	4 (6.2)	20 (23.5)	30 (38.0)	<0.0001
Number of incidents: one/ recurrent	0 (0.0)/ 4 (6.2)	9 (10.6)/ 11 (12.9)	19 (24.1)/ 11 (13.9)	0.04
Presence of paresis	19 (29.2)	55 (64.7)	69 (87.3)	<0.0001
Severity of paresis, NIHSS limb impairment	46 (70.8)/ 18 (27.7)/ 1 (1.5)/	30 (35.3)/ 30 (35.3)/ 6 (7.1)/	10 (12.7)/ 18 (22.8)/ 8 (10.1)/	<0.0001
0/ 1-2/ 3-4/ 5-6/ 7-8/ >8	0/ 0/ 0	10 (11.8)/ 9 (10.6)/ 0	16 (20.3)/ 24 (30.4)/ 3 (3.8)	
Presence of sensory impairment	26 (21.6)	44 (51.8)	50 (63.3)	0.02
Presence of neglect	22 (33.8)	67 (78.8)	69 (87.3)	<0.0001
Severity of neglect, no/mild/moderate/severe	43 (66.1)/22 (33.9)/0 (0.0) /0 (0.0)	18 (21.2)/ 53 (62.3)/ 8 (9.4)/ 6 (7.1)	10 (12.7)/ 44 (55.7)/ 16 (20.2)/9 (11.4)	<0.0001
Presence of depression	1 (1.5)	3 (3.5)	13 (16.5)	0.0007
Presence of apraxia	9 (13.8)	29 (34.1)	40 (50.6)	<0.0001
Presence of aphasia	24 (36.9)	43 (50.6)	38 (48.7)	0.21
Severity of aphasia, NIHSS 1/ 2/ 3	19 (79.2)/ 4 (16.6)/ 1 (4.2)	24 (55.8)/ 15 (34.9)/ 4 (9.3)	15 (39.5)/ 15 (39.5)/ 8 (21.0)	0.03
Presence of dysphagia acute	12 (18.4)	33 (39.4)	51 (64.6)	<0.0001
admission	3 (4.6)	11 (13.1)	22 (27.9)	<0.0001
discharge	2 (3.1)	2 (2.4)	15 (19.0)	<0.0001
DNR acute	0 (0.0)	2 (2.3)	19 (24.1)	<0.0001
admission	0 (0.0)	0 (0.0)	18 (22.8)	<0.0001
discharge	0 (0.0)	0 (0.0)	10 (12.7)	<0.0001
Number of comorbidities 0/ 1-2/≥3	16 (24.6)/ 44 (67.7)/ 5 (7.7)	13 (15.3)/ 64 (75.3)/ 8 (9.4)	7 (8.9)/ 53 (67.1)/ 19 (24.0)	0.005
Charlson index 0/ 1-2/ ?3	53 (81.5)/ 12 (18.5)/ 0	60 (70.6)/ 24 (28.2)/ 1 (1.2)	43 (54.4)/ 32 (40.5)/ 4 (5.1)	0.005
ICH = intracerebral hemorrhage, SAH = subarachnoid hemorrhage, NIHSS = National Institutes of Health Stroke Scale, DNR = Do Not Resuscitate				

Table 2: Clinical characteristics at admission (categorical variables) of the subgroups with between-group differences.

A fall was defined as an event which resulted in a person coming to rest inadvertently on the ground or another level and other than a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis such as stroke or an epileptic seizure. A near fall was defined as a major stumble event and/ or loss of balance reported by a staff member that would have resulted in a fall if sufficient recovery mechanisms were not activated and/ or external control or assistance given. Attended and unattended incidents were included. Careful electronic reporting of all fall and near-fall events was started before the study onset in April 2015.

Scales: The CBS is a measure of functional neglect in spontaneous behavior in personal, peri- and extra-personal space. It is based on direct observation of 10 real-life situations, i.e. grooming, dressing, eating, mouth cleaning, gaze orientation, knowledge of limbs, auditory attention, moving (collisions), spatial orientation, and finding personal belongings. It captures mild neglect better than traditional paper-pencil tests. The total score 1-10 means mild, 11-20 moderate, and 21-30 severe neglect [14,15].

The NIHSS is a scale of key components of a standard neurological examination used to assess stroke severity from 0-42 ("normal functioning" – "coma"). Total scores 1-4 mean mild, 5-15 moderate, 16-20 severe, and 21-42 very severe stroke. (https://www.stroke.nih.gov/documents/NIH_Stroke_Scale_508C.pdf).

Functional variables

The functional variables included admission and discharge FIM total score and motor and cognitive sub-scores, dependence level, domain and item scores, and FIM change (Table 3).

	Home without service			Home with service			Institution			Group 1 vs 2			Group 1 vs 3			Group 2 vs 3			Groups 1+2 vs 3		
Variables Median (IQR, range)	Group 1 n= 65			Group 2 n= 85			Group 3 n= 79			difference between medians (95% CI), p											
Time since stroke onset	28	14, 46	3-139	36	20, 63	6-219	61	29, 97	8-238	-6.5	-14, 1	0.4	-26.5	-39, -14	0.0004	19	7, 31	0.0024	22.5	12, 33	0.0004
Lenght of stay	14	10, 18	3-39	28	20, 42	4-102	28	17, 46	4-91	-14.5	-18, -11	0.0004	-15	-20, -10	0.0004	0	-5, 5	1.0	7.5	3, 12	0.006
NIHSS 24 h	7	4, 9	0-35	11	7, 15	1-35	17	12, 22	3-38	-4	-6, -2	0.0004	-10	-12, -8	0.0004	6	4, 8	0.0004	8	6, 10	0.0004
admission	3	1, 5	0-11	7	4, 9	1-19	11	7, 16	1-23	-4	-5, -3	0.0004	-8	-10, -6	0.0004	4.5	3, 6	0.0004	5.5	4, 7	0.0004
Severity of paresis	2	1, 2	1-3	2	1, 6	1-8	6	2, 8	1-14	-1.5	-3, 0	0.01	-4	-5, -3	0.0004	-2	-3, -1	0.006	2.5	1, 4	0.0001
CBS (admission)	0	0, 1	0-9	3	1, 8	0-30	6	2, 14.5	0-29	-2.5	-4, -1	0.0004	-6	-8, -4	0.0004	2.5	1, 4	0.0164	4	3, 5	0.0004
FIM at admission																					
dependence level	6	6, 6	2-7	5	4, 6	2-6	3	2, 4	1-5	1	1, 1	0.0004	3	3, 3	0.0004	-2	-2, -2	0.0004	-2.5	-3, -2	0.0004
total	118	112, 123	47-126	96	82, 110	38-121	62	46, 78	18-99	19.5	4, 25	0.0004	54.5	49, 60	0.0004	-33.5	-40, -27	0.0004	-43.5	-49, -38	0.0004
motor	88	83, 90	37-92	68	51, 81	22-91	39	26, 51	13-74	16.5	11, 22	0.0004	46.5	42, 51	0.0004	-28	-34, -22	0.0004	-37	-42, -32	0.0004
self-care (mean)	6.8	6.5, 7	2.8-7	5.3	4, 6.3	1.8-7	3.2	2.5, 3.8	1-5.5	1.3	0.8, 1.7	0.0004	3.6	3.3, 3.8	0.0004	-2.1	-2.5, -1.7	0.0004	-2.8	-3.2, -2.5	0.0004
sfincter control (mean)	7	7, 7	1-7	6.5	5, 7	1-7	3.2	2.5, 3.8	1-5.5	0.25	0, 0.5	0.0004	4	3, 5	0.0004	-2.8	-3.5, -2	0.0004	-2.8	-3.2, -2.5	0.0004
bladder	7	7, 7	1-7	7	4, 7	1-7	1	1, 1.5	1-7	0	0, 0	0.0004	5.5	5, 6	0.0004	-3.5	-5, -2	0.0004	-4.5	-6, -3	0.0001
bowel	7	7, 7	1-7	7	6, 7	1-7	4	1, 6	1-7	0	0, 0	0.006	3	1, 5	0.0004	-2	-3, -1	0.0004	-2.5	-4, -1	0.0001
transfers (mean)	7	6, 7	4-7	6	4, 6.7	1-7	3	1, 6	1-7	1	0.7, 1.3	0.0004	3.7	3.3, 4	0.0004	-2.5	-3, -2	0.0004	-3.3	-3.7, -3	0.0004
locomotion (mean)	6	6, 7	2-7	6	5, 6	1-7	4	2, 6	1-7	1	1, 1	0.0004	2	1, 3	0.0004	-1.5	-2, -1	0.0004	-1.5	-2, -1	0.0004
stairs	6	5, 7	1-7	1	1, 5	1-7	1	1, 1	1-5	3	2, 4	0.0004	5	5, 5	0.0004	-0.5	-1, 0	0.0004	-3	-4, -2	0.0004
cognitive	32	29, 34	10-35	28	25, 32	12-35	24	15, 28	5-34	3	1, 5	0.0004	8	6, 10	0.0004	-5.5	-8, -3	0.0004	-7	-9, -5	0.0004
communication (mean)	6.5	5.5, 7	2-7	5.5	4.5, 6.5	1.5-7	4.5	2.5, 6.5	1-7	0.75	0.5, 1	0.0008	1.75	1, 2.5	0.0004	-0.75	-1.5, 0	0.01	-1.25	-2, -0.5	0.0004
social cognition (mean)	6.3	5.7, 7	1.3-7	6	5.3, 6.3	2.7-7	4.7	3, 5.3	1-6.7	0.5	0.3, 0.7	0.003	1.7	1.3, 2	0.0004	-1.3	-1.7, -1	0.0004	-1.3	-1.7, -1	0.0004
FIM progress																					
efficiency	0.125	0, 0.4,	-0.3-1.6	0.4	0.1, 0.6	-0.4-1.6	0.3	0.1, 0.6	-1-1.5	-0.2	-0.3, -0.06	0.004	-0.1	-0.23, -0.03	0.04	-0.06	-0.2, 0.05	1.0	0.03	-0.06, 0.1	1.0
effectiveness (%)	1.7	0, 5.4	-1.7-131.9	11.5	3, 28.6	-4.8-150	12.6	4.6, 36.8	-25.0-133.3	-8.5	-12.6, -4.4	0.0004	-10	-14.1, -5.9	0.0004	1.22	-3.7, 6.1	1.0	5.8	2.3, 9.3	0.006
corrected total effectiveness	0.3	0, 0.6	-0.2-1	0.4	0.2, 0.6	-0.4-0.8	0.1	0.04, 0.3	-0.4-0.8	-0.07	-0.2, 0.04	0.88	0.1	0.01, 0.2	0.14	-0.23	-0.3, -0.1	0.0004	-0.2	-0.3, -0.1	0.0004
corrected motor effectiveness	-0.06	-0.3, 0	-11, 15	-0.03	-0.6, 1.4	-22, 28	0.2	0.04, 0.8	-6.7-19	-0.2	-0.3, 0.04	0.81	-0.4	-0.6, -0.3	0.0004	0.3	0.09, 0.6	0.03	0.4	0.2, 0.6	0.0004
motor effectiveness with adv. corr.	-0.1	-0.4, -0.03	-11, 15	0	-0.8, 1.8	-22, 28	0.3	0.06, 1.0	-6.7-19	-0.4	-0.8, 0.008	0.30	-0.7	-0.9, -0.4	0.0004	0.4	0.04, 0.7	0.12	0.5	0.3, 0.7	0.0004

IQR = Interquartile range; CI = Confidence limits; NIHSS = National Institutes Health Stroke Scale; CBS = Catherine Bergego Scale; FIM = Functional Independence Measure

Table 3: Clinical characteristics and functioning (continuous variables) of the subgroups using Kruskal-Wallis test. Difference on Hodges-Lehmann estimate for median difference. All pairwise comparisons are Bonfenoni corrected.

The FIM instrument: As part of the formal rehabilitation program, a rehabilitation nurse, trained and accredited in accordance with the Uniform Data System standards as a Functional Independence Measure (FIM®) rater, assessed the level of functioning of each rehabilitant at admission and discharge using an electronic FIM tool (FIM® version 5.2, Amherst, NY, USA). The FIM is a measure of dependence and consists of two sub-scales: motor FIM including four domains (13 items): self-care (eating, grooming, bathing, dressing upper and lower body and toileting), sphincter control (bladder and bowel management), transfers (bed/chair/wheelchair, toilet and tub/shower), locomotion (walk/wheelchair/both and stairs) and cognitive FIM including two domains (5 items): communication (comprehension and expression), and social cognition (social interaction, problem solving and memory). The total score ranges from 18-126, motor sub-score from 13-91, and cognitive sub-score from 5-35. Each item is measured on a 7-point scale ranging from 1 (total assistance) to 7 (complete independence). The total score ranges from 18-126, motor sub-score from 13-91, and cognitive sub-score from 5-35.

FIM efficiency is the average change in FIM score per day. This statistic is calculated as the mean change in FIM score during the rehabilitation divided by the mean length of stay. FIM effectiveness is FIM at discharge – FIM at admission × 100%. Corrected FIM effectiveness is calculated as FIM effectiveness/(A - FIM on admission); A is generally taken to be 126 points for total FIM score and 91 points for motor FIM score. This corrected version of FIM effectiveness corrects the ceiling effect present in FIM gain. FIM motor effectiveness with advanced correction corrects for both floor and ceiling effects and is calculated so that motor FIM effectiveness is around 0.65 whereupon A varies being 42, 64, 79, 83, 87, 89, or 91 points when the admission FIM motor sub-score is 13-18, 19-24, 25-30, 31-36, 37-42, 43-48, or 49-90 points, respectively. (http://udsmr.org).

Outcome variables

The three discharge categories were chosen as the dependent outcome variables to detect possible differences in predictive factors between the subgroups.

The same dataset was used in part 2 of this study. Part of the participants was also included in previous studies [16-18].

Statistical analysis

Categorical variables were described using frequencies and percentages and for continuous variables medians with range of values and IQR (interquartile range) percentiles were used. The comparisons between the three rehabilitant subgroups for continuous variables were carried out using the non-parametric Kruskal-Wallis test and for pairwise comparisons the Mann-Whitney U-test with Bonferroni correction was used. Difference on Hodges-Lehmann estimate for median difference was used. With categorical variables comparisons between subgroups were assessed with Chi-Squared test, or, in the case of small cell frequencies, Fisher's exact test. The factors found to have a significant bivariate association (the lowest probability) with outcome variables (discharge categories) were included as independent variables in an ordinal logistic regression model with discharge categories as dependent variables in descending order (increasing support). For a one unit increase in one independent variable at a time (given that the other variables in the model were held constant), the odds of moving from home without service to home with service or institution were studied. Logistic regression analysis for institutionalization was also conducted. To avoid oversaturation of these analysis, the clinically most interesting explicatory variables were chosen. Possible multicollinearity was checked; correlation coefficient ≥ 0.8 and /or tolerance value <0.1 was considered a sign of multicollinearity. P-values below 0.05 (two-tailed) were considered statistically significant. Statistical analyses were performed using SAS 9.4 for Windows (SAS Institute Inc., Cary, NC, USA).

Results

Of the 229 rehabilitants included in the study, 65 (28.5%) were discharged home without service, 85 (37.1%) with service, and 79 (34.5%) were discharged to institutional care.

Demographic and social data of the three rehabilitant subgroups are shown in Table 1. Significant differences between the three subgroups were found in age ($p<0.0001$), working status ($p<0.0001$) and years of education ($p=0.04$). Gender ($p=0.6$) and living situation (cohabiting) ($p=0.06$) were not significantly different between the three subgroups.

Significant between-group differences were found in several clinical and functional characteristics (Tables 2 and 3): 24 hour and admission NIHSS, admission FIM total and dependence score, FIM motor and cognitive sub-score, all studied domain and item scores, FIM change during the stay, time from stroke onset to rehabilitation, length of stay, ability to walk, number of falls and near-fall incidents, presence and severity of paresis and neglect, presence of sensory impairment, apraxia, depression, dysphagia, and a DNR decision, severity (but not presence) of aphasia, number of comorbidities, and Charlson index.

Of the rehabilitants discharged home without service, 64 (98.5%) had a total FIM score of ≥ 80 at admission, only 1 (1.5%) <80, of those discharged home with service the corresponding figures were 67 (78.8%) and 18 (21.2%) and of those institutionalized 16 (20.2%) and 63 (79.8%), respectively. Sensitivity and specificity of admission FIM score 80 for distinguishing those discharged home without service, secondly those discharged home with service and thirdly all rehabilitants discharged home from those institutionalized were 98% and 78%, $p<0.0001$, 79% and 80%, $p<0.0001$, and 87% and 79%, $p<0.0001$ respectively, and for distinguishing those discharged home without service from those discharged with service were 98% and 21%, $p<0.0001$, respectively.

Table 4 demonstrates three-class bivariate associations in ordinal logistic regression analysis between discharge disposition in descending order, i.e. home discharge without (n=65) or with service (n=85) or institution (n=79) and one unit increase of variables potentially affecting discharge disposition. Significant associations were found in variables age, cohabiting, still working, time from stroke onset, length of stay, NIHSS, all FIM admission scores, FIM effectiveness and corrected total FIM effectiveness, SAH *vs.* infarction, ambulatory ability, presence and number of falls, "no *vs.* recurrent falls/ incidents", presence of sensory impairment, apraxia, dysphagia and depression, presence and severity of paresis and neglect, severity of aphasia, DNR decision, number of comorbidities and Charlson comorbidity index.

In two-class logistic regression analysis home without and with service (n=150) versus institution (n=79) statistically significant bivariate associations for institutionalization were found in the same variables as in Table 4 except for FIM effectiveness (%), SAH *vs.* infarction, and "no *vs.* recurrent incidents".

For comparison, in two-class logistic regression analysis including only the subgroup discharged home with service (n=85) and those institutionalized (n=79) the same variables as in Table 4 were statistically significant except for the variables cohabiting, length of stay, FIM effectiveness (%), presence of falls, sensory impairment and neglect.

Of the variables significant in bivariate analysis ten explicative factors with specific motivations were included in the final regression analysis. Variables still working and cohabiting correlated strongly with age (Spearman r -0.67 and 0.98, respectively) and were not included in the multivariate model. Length of stay was not included as many factors like organization of health care, availability of resources and patients´ individual set of circumstances affect length of rehabilitation. However, time from stroke to admission of rehabilitation has been considered a significant factor in stroke outcome research and it was included. To avoid oversaturation of the analysis, functional factors were preferred to clinical characteristics (sensory impairment, apraxia, paresis and aphasia). FIM sphincter control and locomotion (Spearman r 0.61) were included, but not other FIM motor domains because of high correlation of these two domains with self-care (r 0.82 and 0.74), transfers (r 0.77 and 0.76) and stairs (r 0.63 and 0.67), but less with cognition (r 0.50 and 0.30), which was included. Of the many mobility variables FIM ambulatory and falls were not included, instead FIM locomotion with the widest scale was chosen and corrected FIM effectiveness as past evidence on the impact of progress in rehabilitation has been insufficient. SAH (n=11, 2 of them institutionalized) and depression (n=17, 4 of them institutionalized) were not included because of few cases. As more research on the effect of dysphagia and neglect has been proposed they were also included. Stroke severity (NIHSS) as a specific measure for the present population was preferred to Charlson index; in addition DNR decision as a new variable in this context representing high disease severity was included. Number of comorbidities was also excluded as more stroke specific variables were preferred; in addition, in eleven variable model the number of comorbidities was not found to be a statistically significant predictor in either two- or three-class regression analysis.

Variables: OR (95% Cl), p-value	**Home without *vs.* with service *vs.* institution**		
<u>*Continuous variables: median*</u>	OR	95% Cl	p
Age (1 year increase)	1.1	1.0, 1.1	<0.0001
Education (1 year increase)	0.9	0.9, 1.0	0.06
Gender: male	1.2	0.8, 2.0	0.39
Cohabiting: no	1.8	1.1, 3.0	0.02
Still working: no	3.6	2.2, 6.1	<0.0001
Time since stroke onset (1 day increase)	1.0	1.0, 1.0	<0.0001
Lenght of stay (1 day increase)	1.0	1.0, 1.1	<0.0001
NIHSS 24 h (1 point increase)	1.2	1.1, 1.2	<0.0001
admission (1 point increase)	1.3	1.3, 1.4	<0.0001
Severity of paresis (1 point increase)	1.5	1.3, 1.7	<0.0001
CBS (1 point increase)	1.1	1.1, 1.2	<0.0001
FIM at admission (1 point increase)			
dependence level	0.2	0.2, 0.3	<0.0001
total	0.9	0.9, 0.9	<0.0001
motor	0.9	0.9, 0.9	<0.0001
self-care (mean)	0.3	0.2, 0.3	<0.0001
sphincter control (mean)	0.5	0.4, 0.6	<0.0001
bladder control	0.6	0.5, 0.6	<0.0001
bowel control	0.5	0.4, 0.6	<0.0001
transfers (mean)	0.4	0.3, 0.5	<0.0001
locomotion (mean)	0.1	0.1, 0.2	<0.0001
stairs	0.5	0.4, 0.6	<0.0001
cognitive	0.9	0.8, 0.9	<0.0001
communication (mean)	0.2	0.1, 0.4	<0.0001
social cognition (mean)	0.4	0.3, 0.5	<0.0001
FIM progress (increase)			

efficiency	1.3	0.7, 2.5	0.38
effectiveness (%)	1.0	1.0, 1.0	0.002
corrected total effectiveness	0.2	0.1, 0.5	0.0006
corrected motor effectiveness	1.0	1.0, 1.1	0.30
motor effectiveness with advanced correction	1.0	1.0, 1.1	0.30
Categorical variables: no *vs.* yes if not otherwise specified			
Diagnosis: infarction			reference
SAH	0.1	0.0, 0.4	0.002
ICH	1.1	0.7, 1.9	0.63
Localization: right hemispheral			reference
left hemispheral	1.1	0.6, 1.9	0.78
both sides	0.7	0.3, 1.5	0.36
posterior circulation	0.8	0.4, 1.9	0.67
FIM ambulatory			reference
sedentary	26.9	13.2, 54.7	0.0001
ambulatory and sedentary	8.9	2.4, 32.7	0.0009
Falls or near falls during the stay	1.7	1.2, 2.3	0.0008
Number of falls: no *vs.* one incident	0.3	0.1, 0.5	<0.0001
no *vs.* recurrent incidents	3.4	1.1, 10.1	0.03
Presence of paresis	0.1	0.1, 0.2	<0.0001
Presence of sensory impairment	0.5	0.3, 0.8	0.005
Presence of neglect	0.1	0.1, 0.2	<0.0001
Presence of depression	0.1	0.0, 0.4	0.0008
Presence of apraxia	0.3	0.2, 0.5	<0.0001
Presence of aphasia	0.7	0.4, 1.2	0.19
Severity of aphasia, mild			reference
moderate to severe	0.4	0.2, 0.8	0.32
global	0.2	0.1, 0.7	0.009
Presence of dysphagia acute	0.2	0.1, 0.4	<0.0001
admission	0.04	0.0, 0.2	<0.0001
DNR in the acute phase	0.04	0.0, 0.2	<0.0001
Number of comorbidities 1-2 *vs.* 0	2.1	1.1, 4.1	0.03
≥3 *vs.* 0	5.7	2.2, 14.3	0.0002
Charlson comorbidity index 3 *vs.* 1-2	4.7	0.5, 45.7	0.18
0 *vs.* 1-2	0.4	0.2, 0.7	0.002
OR = odds ratio, Cl = confidence limits, NIHSS = National Institutes of Health Stroke Scale, CBS = Catherine Bergego Scale, FIM = Functional Independence Measure, DNR = do not resuscitate, p <0.05 is statistically significant			

Table 4: Bivariate associations between discharge disposition with increasing support and factors potentially affecting discharge disposition.

Results of ordinal logistic regression analysis are shown in Table 5: higher age, lower admission FIM scores in sphincter control, locomotion, and cognition, higher severity of neglect and presence of acute phase dysphagia/ feeding tube were found to be the most influential predictors for discharge disposition towards increasing support. In two-class logistic regression analysis including all rehabilitants (n=229) higher age, lower admission FIM scores in sphincter control, locomotion, and cognition and lower FIM gain were the most significant independent predictors for institutionalization

	3-class ordinal regression analysis: increasing support (home without/ with service/ institution)			**2-class logistic regression analysis: risk of institutionalization**		
Variables	OR	95% CI	p	OR	95% CI	p
Age	1.1	1.0, 1.1	**<0.0001**	1.1	1.0, 1.1	**0.006**
NIHSS 24-hour	1.0	1.0, 1.1	0.30	1.0	1.0, 1.1	0.18
Dysphagia (no *vs.* yes)	0.5	0.2, 0.9	**0.02**	0.6	0.3, 1.5	0.29
DNR decision (no *vs.* yes)	0.3	0.1, 2.2	0.29	0.3	0.0, 2.0	0.27
Time since stroke	1.00	1.0, 1.0	1.0	1.0	1.0, 1.0	0.43
FIM sphincter control	0.7	0.6, 0.8	**0.0002**	0.7	0.5, 0.8	**0.0003**
FIM locomotion	0.3	0.1, 0.6	**0.001**	0.4	0.2, 1.0	**0.05**
FIM cognition	0.9	0.9, 1.0	**0.002**	0.9	0.9, 1.00	**0.04**
CBS	1.1	1.0, 1.1	**0.04**	1.0	0.9, 1.1	0.81
Corrected FIM effectiveness	0.3	0.1, 1.1	0.07	0.1	0.0, 0.6	**0.009**
FIM = Functional Independence Measure; CBS = Catherine Bergego Scale; NIHSS = National Institutes of Health Stroke Scale; DNR = Do Not Resuscitate; OR = Odds Ratio, Cl = Confidence limits, p<0.05 is statistically significant						

Table 5: Results of regression analysis with ten variables significant in bivariate analysis: Factors associated with discharge disposition.

Discussion

Of the 229 rehabilitants, 65.6% were discharged home, 56.6% of them with the aid of social services. The rehabilitants discharged to an institution were oldest, most frequently not working and had the highest stroke and disease severity and disability, most comorbidities and the longest time from stroke onset to rehabilitation admission. Those discharged home without service, on the other hand, were youngest, most often still working and they had the shortest length of stay, the mildest stroke severity and disability and least possibility to improve compared to the other two subgroups with a possibility to a clinically significant FIM gain. The subgroup discharged home with service had higher overall functional improvement and shorter time from stroke onset to rehabilitation than those institutionalized despite the equal length of rehabilitation in-stay. These results are largely in accordance with most previous studies where up to 80% of stroke rehabilitants have been able to return home [9], the range, however, varying widely being highest (close to 100%) among young stroke patients [19, 20] and those with a modest functional impairment [20] and lowest (45%) in severe stroke [21]. About half of all stroke survivors eventually discharged home have been found to require assistance in various activities of daily living [22]. On the basis of most studies in subacute rehabilitation hospitals, high age [6,10,23-28] with rare exceptions [29,30], and high stroke severity have been found to be the most important predictors of institutionalization [9,20,25,28,31]. Higher motor and cognitive gain in patients with severe disability has been found to have a positive effect on discharge disposition [7,32,33], but not always [26]. Co-morbidities [8,9,25] have also been found to be associated with discharge disposition. Early inpatient rehabilitation onset after acute care has been found to be associated with home discharge and with higher motor and cognitive improvement [23,32]. Delayed admission, on the other hand, has been linked with longer length of stay [32]. However, many factors may affect timing of rehabilitation including policy factors, availability of resources and the presence of a family member as a caregiver [34]. Lower admission functional ability has been found to be related to longer length of stay [9,35], which, on the other hand, can promote possibility to community discharge instead of institutionalization [36] especially among those with a realistic possibility to return home corresponding primarily to the subgroup "home with service" in the current study.

Severity has been measured with various neurological and functional instruments [5,9,10,37], the most common being admission FIM scores, Barthel index or NIHSS score, but also ambulatory and gait ability have been found to be associated with discharge destination. Even if FIM has been the most consistent predictor of discharge destination, no clear cut-off score exists. In the present population, the rehabilitants discharged home had mostly mild to moderate stroke severity in the acute phase, those institutionalized a severe stroke with clear between-group differences in both NIHSS and FIM scores between the three subgroups. Of those with admission FIM score of ≥ 80 90% returned home (44% without service and 46% with service), of those with a score of <80 only 23% returned home (1% without service and 22% with service). Admission FIM score of 80 was found to have high sensitivity and specificity for distinguishing those discharged to community from those institutionalized. These findings are largely in accordance with previous evidence on acute phase NIHSS [37] and admission FIM [6,37,38] with cut-off scores for FIM varying from 65 [33] to 80 [7]. However, previous research has pointed out that regardless of stroke severity and despite the strength of functional performance, outcome measures cannot be used in isolation of the patients' biopsychosocial factors and individual set of circumstances [37].

In a number of previous studies both gender and living with a family member have been found to be associated with discharge destination. In the present population, however, no significant differences between the three subgroups were found in gender or cohabiting. Previously usually female gender has been found to be more associated with institutional discharge after subacute stroke rehabilitation [8,29], in other populations male [30,39], but these relations have usually been weak [40] and in some populations no association with gender has been found [41,42]. In a large Taiwanese study the gender difference disappeared in multiple regression model [25]. Also, in a recent meta-analysis gender was not found to be a significant predictor for discharge destination [9]. The finding of female gender being a significant predictor of disability [43] may be explained by the fact that stroke occurs later in life for women [44] and age, per se has been found to be associated with stroke severity and disability [23,45,46]. In addition, increased number of comorbidities and decreased functional reserve are common in older patients. Thus, age and increased comorbidities may be important confounders for gender differences [30,41]. The gender differences have also been explained by social factors; older women have a greater risk of long-term institutional placement as many of them do not have fit enough spouses as caregivers [25,29] and men, on the other hand, who lack an informal caregiver have a greater risk of institutionalization as they are less often connected to non-spousal caregivers than women [39]. In a number of studies living situation, especially a spouse or a caregiver has been found to be an independent predictor of home discharge after hospitalization for acute stroke [5,9], after subacute inpatient stroke rehabilitation [5,9,10,25,26,36,47] and also after general geriatric inpatient rehabilitation [4], but not always [9], and having an employed caregiver or living outside of the home prior to stroke have been found to be associated with greater likelihood of long-term care [9,10]. For individuals with severe stroke, discharge home has been found to be unlikely in the absence of a spouse or an available caregiver [24,48]. The inconsistent findings concerning gender and availability of an informal caregiver may be due to cultural factors and policies, differing study selection criteria, and the use of different analytic variables and methods in addition to various confounding factors. The finding of gender or cohabiting not being predictive of discharge disposition in the current population may at least partly be due to the fact that social services in the community offer assistance in daily activities when needed, and there is also a possibility to get a formal caregiver when an informal caregiver is not an option, but also in addition to informal caregiving to ease the burden without high costs.

Previously, few studies have focused on investigating the impact of various clinical characteristics on discharge disposition among stroke rehabilitants. In the present study, the rehabilitants with SAH were most frequently discharged home (82%) even if they could have high NIHSS scores in the acute phase because of initial reduction or loss of consciousness. Otherwise stroke type (infarction *vs.* hemorrhage), localization or laterality were not associated with discharge disposition, which is in agreement with previous findings: although hemorrhagic strokes have a poorer outcome and discharge disposition in the acute stage, outcomes of ischemic and hemorrhagic strokes discharged from subacute rehabilitation have been shown to be similar [6,41,49]. In this study, a large number of clinical and functional factors were found to have a bivariate association with discharge disposition; in regression analysis age, FIM domains sphincter control, locomotion, and cognition, total FIM gain, dysphagia/ feeding tube and severity of neglect were found to be the most influential predictors for discharge disposition. These findings are supported by previous research using multivariable analysis, where right hemisphere stroke [10] and neglect [29] were found to be associated with institutional discharge, but not laterality of impairment [6, 41]. Neglect has also been found to be associated with severity of stroke and disability and to affect outcome in rehabilitants with right stroke and more severe neglect [17,18]. In some studies the finding of right hemisphere stroke predicting institutionalization more than left hemisphere damage has been explained by the higher occurrence and severity of neglect in right stroke [10]. In a large population, cognitive deficits, aphasia, ataxia, neglect and dysphagia had univariate association with discharge disposition after subacute rehabilitation, but in multivariate analysis only cognitive impairment and dysphagia were associated with institutional discharge [6]. In addition, absence of dysphagia and indwelling bladder catetrization have been shown to be important prognostic factors for home discharge in a multicenter study [34]. Urinary [28,50] and bowel incontinence [10] have been found to be associated with discharge destination [10,28], with cognition and transfer FIM scores [50] and with severe disability after stroke [9]. Furthermore, FIM bladder, bed transfer and memory scores have been included in a discharge destination prediction scale based on admission motor impairment (S-Stream) and FIM [51].

Some limitations to this study must be elucidated. Even if the number of rehabilitants was limited, it was adequate for the purpose of this research. In addition, no data were missing in this prospective study. Rehabilitation population is always selected so the results cannot be generalized to the entire stroke population. The data were collected in a restricted area which also affects the generalizability of the findings to different healthcare delivery settings and cultures. However, research on a local scale has been recommended to compare different regimes. The application of cross-sectional study design does not allow confirmation of causal relationships of disability, i.e. whether they are based on the disease itself or its secondary consequences. Compared with motor impairments, the variance in cognitive abilities was more limited as the rehabilitants were selected to have sufficient mental capacity to be able to actively participate in various therapies. Still, cognition was found to be an independent predictor for discharge disposition. Although the FIM may not capture all aspects of functioning associated with discharge disposition, it has been found to accurately predict functional outcome post stroke. Other potential explanatory variables not used in the current study might also influence outcome; however, we did have a large variety of independent variables compared with previous studies. As oversaturation of the multiple regression analysis should be avoided, future studies are recommended to select possible additional variables in a different and more focused setting.

Conclusion

The most influential predictors for discharge disposition towards increasing level of support were higher age, lower admission FIM scores in sphincter control, locomotion and cognition, higher severity of neglect, and presence of acute phase dysphagia/ feeding tube. Among predictors for institutionalization were higher age, lower admission FIM scores in sphincter control, locomotion and cognition and lower total FIM gain.

Consent

Patients have given their informed consent for participation in the research study.

Ethical Approval

The Ethics Committee of the University and University Hospital approved the study (19.5.2015, 73/2015). The ethical standards of the World Medical Association Helsinki Declaration of 1975, as revised in 1983 were followed.

Conflicts of Interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Received date: October 11, 2020; **Accepted date:** December 05, 2020; **Published date:** December 14, 2020

Citation: Tarvonen-Schröder S, Niemi T, Koivisto M (2020) Factors Predicting Discharge Disposition after Sub-acute Stroke Rehabilitation. *Front Med Health Res* 2(1): 111.