

Effect of risk factors on functional outcome after stroke rehabilitation

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ABSTRACT

Objectives: The incidence of stroke and the demand for rehabilitation services continues to increase. Risk factors may act as stroke outcome predictors and hence determine the type and intensity of rehabilitation. Our aim is to investigate stroke outcome predictors that will define groups with maximal or minimal benefit from rehabilitation after stroke.

Methods: Our longitudinal prospective study included 111 ischemic stroke patients, admitted consecutively to the Rehabilitation Department, Hamad Medical Corporation, Qatar, during 2000-2001. We analyzed the influence of modifiable risk factors: diabetes mellitus (DM), hypertension (HTN), ischemic heart disease (IHD) and non-modifiable factors: age, gender, race and side of lesion on stroke outcome. All patients received regular rehabilitation and underwent an evaluation on admission and discharge, using the Modified Barthel Index.

Results: Statistical analysis demonstrated that the group of patients with IHD showed greatest improvement after 3 months of rehabilitation. The group without co-morbidities followed this, and then the HTN, DM, combined DM and HTN and combined HTN and IHD groups. The group that suffered from combined DM, HTN, and IHD did not show improvement. Non-modifiable risk factors showed no significant differences. However, younger patients showed a tendency for better improvement.

Conclusions: Those patients with modifiable risk factors had significant impact on rehabilitation outcome (p -value = 0.009). Those with one or 2 co-morbidities had the highest score of improvement after rehabilitation while the group of patients with more than 2 co-morbidities did not show improvement. However, non-modifiable risk factors did not play a significant role in stroke outcome.

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Stroke is one of the most frequently occurring, disabling and costly diseases that continues to have an enormous impact on public health in almost all nations.¹ We recognize it as one of the leading causes of morbidity and mortality worldwide and its economical burden is among the highest of all diseases. The annual incidence of stroke in Europe including first and recurrent stroke varies from 150-280 per 100,000. One third of the stroke patients are younger, and two-thirds older than 65 years age.² In addition to being a serious medical condition that affects many

brain functions, including diminution of physical and mental capacity, stroke affects each person differently and to a variable extent.^{3,4} Ischemic stroke is by far the most frequent subtype of acute stroke and comprises more than 80% of patients. Functional prognosis of ischemic stroke patients is worse than in those who survive hemorrhagic stroke.⁵ Medical rehabilitation is the field dedicated to reducing the negative impact caused by cerebrovascular disease on the physical, cognitive and psychological potential of human beings. We use carefully planned rehabilitation programs that

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assist patients in regaining their ability to function independently at home, work, and community, and consistent with the physiological and environmental limitations. The earlier the rehabilitation program begins the more likely the patients regain their ability to function and participate in a productive lifestyle.³ Although it can not reverse the neurological deficit, rehabilitation programs will prevent complications and make the patients more independent. Statistically, the number of stroke patients is decreasing due to treatment of the associated major risk factors, yet the number of patients attending rehabilitation centers is increasing.¹⁻⁵ The cost of rehabilitation is also increasing, and the local health authorities need to be aware of the rehabilitation expenses and its cost effectiveness. The prevalence of stroke, increased rate of survival, and expenses of rehabilitation have resulted in a growing interest in the necessity to identify valid and reliable predictors of functional outcome after programmed stroke rehabilitation. The aim of this study is to investigate the predictors of functional outcome that will define the groups of patients with maximal or minimal benefit from a rehabilitation program after stroke. We will investigate the following 2 questions related to these outcome predictors: 1. Are there any significant differences among the groups of non-modifiable risk factors namely age, gender, race, and side of stroke on functional outcome? 2. What is the significance of the main modifiable risk factors or co-morbid disorders; namely, diabetes mellitus (DM), hypertension (HTN) and ischemic heart disease (IHD) on functional outcome?

Methods. In this prospective study, 111 patients with completed stroke caused by cerebral thrombosis were evaluated using the Modified Barthel Index (MBI) on admission and discharge. The patients with transient ischemic attack (a focal neurological deficit that lasts from 2 minutes-24 hours) or reversible ischemic neurologic deficit (a focal neurological deficit that lasts 24 hours-3 weeks) were excluded from the study. The patients involved in the study were admitted to the Department of Physical Medicine and Rehabilitation (PM&R) at Rumallah Hospital in Qatar during the period 2000-2001. They were referred to the hospital after stabilization in the Neurology Department, with an already established diagnosis by the referring Neurologist. Hamad General Hospital is less than a 10-minute drive from the comprehensive rehabilitation centre at Rumallah Hospital. It is the only referral center available for the whole population of the country. The concurrent total population of Qatar, according to the general census of 2000, was 786,437. The patients included in the study were diagnosed as cerebral thrombosis with weakness (first ever stroke and first rehabilitation admission for stroke). According to the defined protocol, those diagnosed as cardiac embolism, hemorrhage, tumor, subdural hematoma, abscess and trauma as

a cause of hemiplegia were excluded. Diagnosis of cerebral infarction was based on clinical history, CT scan of the brain, supplemented by plain x-rays and laboratory results. All patients were examined and evaluated before stabilization by the referring neurologist and after the period of stabilization by the attending physiatrist. Once stabilization of the patient is achieved, he or she would be referred to PM&R Hospital for admission and further treatment. Criteria for referral of patients to the rehabilitation hospital were: absence of signs of further progression of neurological deficit, level of consciousness that permits 2 or preferably 3 steps direction, retained short term memory to remember and apply what was learned the day before. The rehabilitation team reviews the complete medical records from the referring hospital for all participating patients. Standard international classification of diseases (ICD 10) published by the World Health Organization was used as a guide during evaluation of the medical records. The protocol for this study did not differ from PM&R routine clinical practice. The same rehabilitation team evaluated the patients on admission and discharge. All patients were involved in the comprehensive rehabilitation program that includes maintenance medications, nursing care, physiotherapy, occupational and speech therapy. In addition, the patients and their families received psychological and social support. Daily medical supervision was provided. Rehabilitation treatment was scheduled as 5 days per week, and the whole program was reevaluated on a weekly basis. An occupational therapist and social worker organized regular visits to the patients at their homes. These visits were planned to inspect and correct various architectural barriers pertaining to each patient. Assistance included, but was not limited to providing an elevator for patients living above ground floors, constructing slopes on multistep outdoors to allow easy use of wheelchairs, widening entry doors or removing waves when appropriate, changing the Arabian toilet type into the seated ones or providing a toilet chair device, inspection of the kitchen and regular evaluation of patients abilities to decide whether he or she can use hands effectively to perform activities of daily living. This program helped to identify the patient requiring a wheelchair, ankle foot orthosis, walking cane, caliper, or sticks.

Statistical analysis. The assessment methods applied in this study were CT scan of the brain and the MBI. The results were attended and analyzed by a statistician, using the SPSS statistical package and Analysis of Variance (ANOVA).

Results. Measurements and scoring of the MBI for the stroke population are given in **Table 1**. Distribution of age, gender, side of stroke, race, and co-morbid diseases among the patients evaluated in this study is given in **Table 2**. Age ranged from 26-78 years with a mean of 54 (STD = 10.38). No significant

Table 1 - Modified Barthel Index measures in the stroke population.

Modified Barthel Index Scoring				
Independent	Dependent			Activities of daily living function
I Intact	II Limited	III Helper	IV Nil	
10	5	1	1	Drink from cup/eat from dish
5	5	3	0	Dress upper body
5	5	2	0	Dress lower body
0	0	2	0	Don brace or prosthesis
5	5	0	0	Grooming
4	4	0	0	Wash or bathe
10	10	5	0	Bladder incontinence
10	10	5	0	Bowel incontinence
4	4	2	0	Care of perineum/clothing at toilet
15	15	7	0	Transfer chair
6	5	3	0	Transfer toilet
1	1	0	0	Transfer tube or shower
15	15	10	0	Walk on level 50 yards or more
10	10	5	0	Up and down stairs for one flight or more
15	5	0	0	Wheelchair/50 yards only if walking
Total 115				

Table 2 - Rehabilitation outcome predictors: groups, number of patients (No.), percentage from the total patient population (%), mean improvement (MIS) and standard deviation (STD).

Predictor	Groups	No.	(%)	MIS	STD
<i>Age (years)</i>	26-45	16	(14.4)	41.38	26.91
	46-65	67	(60.4)	34.12	28.08
	66-78	28	(25.2)	29.25	26.44
Total		111	(100)	33.94	27.99
<i>Sex</i>	Male	85	76.6	34.78	28.06
	Female	26	23.4	31.19	28.12
Total		111	(100)		
<i>Race</i>	Qatari (Arab)	31	(27.9)	33.03	27.83
	Arab	22	(19.8)	34.22	28.92
	Foreigners	58	(52.3)	34.28	28.2
Total		111	(100)	33.94	27.99
<i>Side of stroke</i>	Right	53	(47.7)	34.72	27.24
	Left	58	(52.3)	33.22	28.87
Total		111	(100)		
<i>Co-morbid disorders</i>	HTN	40	(36)	38.28	28.63
	DM	15	(13.5)	34.73	19.62
	IHD	4	(3.6)	67	45.27
	DM+HTN	22	(19.8)	22.5	23.33
	DM+HTN+IHD	7	(6.3)	18.29	25.49
	DM+IHD	2	(1.8)	0	0
	HTN+IHD	4	(3.6)	22	23.89
	No co-morbidity	17	(15.4)	43.29	26.83
Total		111	(100)	33.94	27.99

HTN - hypertension, DM - diabetes mellitus,
IHD - ischemic heart disease

Table 3 - Analysis of variance (ANOVA) for the age, race and co-morbid diseases predictors.

Predictor	Source	Sum of squares	DF	Mean square	F-ratio	P-value
Age	Between groups	1502.514	2	751.257	0.958	0.38
	Within groups	84652.045	108	783.815		
Total		86154.559	110			
Race	Between groups	35.232	2	17.616	0.022	0.97
	Within groups	86119.327	108	797.401		
Total		86154.559	110			
Co-morbid disorders	Between groups	14089.193	7	2012.742	2.887	0.009
	Within groups	72065.366	103	699.664		
Total		86154.559	110			
DF - Degrees of freedom						

Table 4 - Analysis of T-test for the side and sex of stroke.

Predictor	No.	Mean	Standard deviation	t-value
<i>Side</i>				
Right	53	34.717	27.2442	0.28
Left	58	33.2241	28.8663	
<i>Sex</i>				
Male	85	34.7765	28.0583	0.57
Female	26	31.1923	28.1198	

differences in rehabilitation outcome were observed between the various age groups (p -value = 0.38), (Table 3). However, younger patients demonstrated a trend to greater benefit from rehabilitation programs, particularly those within the age group 26-45 years. The mean improvement scores for the assigned age groups are shown in Table 2. The differences in outcome with respect to gender, race and side of stroke, were statistically insignificant (Tables 3 & 4) (p -value = 0.57, 0.97, 0.28). Co-morbid diseases, however, had a significant impact on rehabilitation outcome (Table 3) (p -value = 0.009). The group of patients with IHD showed the highest improvement score after the rehabilitation program followed by the HTN group, the DM group, the combined DM and HTN group, and the combined HTN and IHD group. The group of patients suffering from combined DM, HTN and IHD did not show improvement.

Discussion. Stroke is currently the third leading cause of death in the United States, surpassed only by heart disease and cancer.³ Furthermore, it has a devastating impact on individuals, their families and the community. Stroke as the most important cause of morbidity and long-term disability imposes an enormous economic burden. The advent of promising

therapies for acute ischemic stroke led to higher expectations for rapid recovery and good outcome. Nevertheless, poor outcome may prevail because ischemic stroke is a heterogeneous disease and several factors could influence its rehabilitation outcome.^{1,6,7}

Until recently, proposals suggested that non-modifiable and modifiable risk factors can act as predictors of stroke outcome and hence can determine the importance to identify the impact of these risk factors on functional outcome before embracing a system that limits access to rehabilitation because of such factors. Among the non-modifiable risk factors, we investigated: age, gender, race, side of stroke (right or left) and the modifiable (co-morbid medical disorders) risk factors: HTN, DM and cardiac disease in this study. Results of our study showed that non-modifiable risk factors such as age, gender, race, and side of stroke had no significant effect on functional outcome, even though younger patients showed a trend towards better improvement compared to the older groups. On the other hand, modifiable risk factors or co-morbid medical disorders had a significant influence on functional outcome.

Recent studies concluded that older age predicts poor outcome.^{8,9} However, we cannot separate the poor outcome of rehabilitation due to advanced age from co-morbidities, and the initial severity of stroke and age are the most powerful predictors of functional recovery. Discrepancies between various studies that associated age with outcome might be due to the correlation between age and co-morbidities.¹⁰ For example, we can associate a history of diabetes or cardiac disease with poor outcome after stroke.¹ The impact of these disorders might be greater in older patients. Although age greater than 65 years has a significant negative effect on discharge from hospital, it is not an independent predictor of functional recovery. Functional recovery may not directly relate to age, but the need for long-term institutional care was greater for the very old. Functional status

evaluated by the Functional Independence Measure (FIM) instrument found that although there was a statistically significant association between age and functional outcome, only a small amount of variation can be explained by age alone.¹⁰ In our study, although younger patients showed a small trend towards better improvement, the age variable did not reach statistical significance, as we could not separate age itself from other variables especially medical co-morbidities.

The importance of gender in predicting stroke outcome is conflicting and less apparent. Animal studies suggest that the outcome is dependent on gender.⁸ This might be a result of estrogen that seems to mediate improvement in outcome after ischemic brain injury. Several human studies associated males with a poorer outcome.¹⁻¹⁰ Contrary to mentioned results, the study performed in Sweden showed that after 3 months, more women were physically and mentally impaired, and dependent on other persons. However, case fatality ratios during the first 3 months were similar in men and women.¹¹ In another study, Jaume et al¹² found that women more often suffered aphasic disorders, visual field disturbances and dysphagia. Our study showed no significant difference in rehabilitation outcome between male and female patients.

Concerning the influence of race on rehabilitation outcome, it is well documented that the incidence of stroke, of various causes varies among races and ethnicities.⁸ In African-Americans, the relative risk of stroke is 2-4 times higher in different age groups than in Native Americans. However, most of the studies found no differences in rehabilitation outcome related to race.¹³ Poorer outcome after rehabilitation in black stroke patients probably relates to delay in initiation of inpatient rehabilitation and low income than to race itself.¹⁴ In our study, the patients originated from 2 different ethnic communities, Arabs (local Qatari and non local) and non Arabs (Indian, Pakistani, Bangladeshi and Sri Lankan), we did not find any significant differences in rehabilitation outcome between these 2 ethnic groups. Also, we did not find literature studies that compare these 2 ethnic groups.

Research on the influence of lesion side on functional outcome has yielded contradictory results. Recent literature reviews suggest that the hemisphere of stroke does not predict outcome, what is consistent with our results. However, Tur et al¹⁵ found that patients with aphasia and depression had a lower FIM score. If we consider aphasia as a consequence of left hemisphere lesion, we can conclude that this location is a less favorable prognostic factor. On the other side, Laufer et al¹⁶ found that functional ability and balance control are equally affected in both right and left hemisphere lesions.

The existence of co-morbid disorders such as DM, HTN or IHD has been associated with poorer outcome after stroke.⁸ Ischemic heart disease was a prominent predictor of survival in multiple studies.³

In our study, the group of patients suffering from multiple disorders such as DM, HTN and IHD did not show any signs of improvement during and after rehabilitation. Those with single medical conditions such as IHD showed the best improvement. Only 4 (3.6%) patients represented this group in our study and as a consequence, the samples of patients with combined DM and IHD, combined HTN and IHD, and combined DM, HTN and IHD, were also relatively small. Nonetheless, the groups of patients with HTN, DM and HTN, DM, and those without co-morbidities, were well represented in the study and showed improvement after rehabilitation. Statistical analysis between and within the various groups with co-morbid disorders was highly significant.

However, there are limitations to our study including the relatively small sample size, short duration, small catchment, or drainage areas of the study and the related ethical concerns pertinent to the stroke patients undergoing rehabilitation. All of these limitations and particularly the ethical concerns suggest that there is no justification to deny access to rehabilitation solely because that group of patients with more than 2 co-morbidities did not improve. We need further research on bigger samples to draw conclusions that are more valid.

In conclusion, ischemic stroke is a heterogeneous disease. We found that many factors influence rehabilitation outcome. Our study confirmed that in patients with ischemic stroke, non-modifiable risk factors like age, gender, race, and the side of lesion (right or left) do not play a significant role in functional outcome, except that the younger group of patients showed a tendency for better improvement. The results in some studies were inconsistent with our findings, probably due to differences in the tested samples and methodology. However, most of the studies are consistent with our results. Regarding modifiable risk factors such as DM, HTN and IHD, we found that patients with IHD showed the greatest improvement after the rehabilitation program. The HTN, DM, combined DM and HTN, and combined HTN and IHD groups followed this. Those suffering from multiple diseases such as DM, HTN, and IHD did not show improvement. Although it cannot reverse the neurological deficits, rehabilitation plays a significant role in functional recovery and improvement of quality of life in stroke patients. Clinicians should be aware of the importance of different factors on rehabilitation outcome of ischemic stroke. It will offer not only realistic expectations to stroke patients and their families, but also contribute to the development of adequate rehabilitation strategies and improve cost effectiveness. It will also support important decisions that we should contemplate and greatly enrich our understanding of ischemic stroke and its treatment. However, due to the ethical concerns, we should give each patient the chance to undergo rehabilitation, regardless of his or her age, sex, race, side of

infarction and co-morbid disorders. Nevertheless, we should document well these clinical attributes. Although we cannot infer causal statistical analysis, factors that we find repeatedly predictive can serve as prognostic markers. The central and continuing roles of outcome analysis are to identify those stroke patients for whom comprehensive rehabilitation can be beneficial, to form treatment expectations that have clinical utility, to develop means of comparing alternative rehabilitation approaches, to justify rehabilitation practice and to measure functional status to ensure that the process of rehabilitation produces high quality care.

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