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Original research article

The Functional Improvements of Stroke Patients Undergoing Rehabilitation: Retrospective Observational Study

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Abstract

Aim: To examine whether advanced age and hypertension influence the functional gains of stroke patients undergoing rehabilitation.

Methods: This was retrospective observational study Department of Physical Medicine &Rehabilitation (PMR), Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India for 12 months. 200 patients with thromboembolic strokes were included. The patients were divided into five age groups: below 50 years, 50-60 years, 60-70 years, 70-80 years and above 80 years. They were further classified into the hypertensive and non-hypertensive groups. Patients' functional performance was assessed on the Functional Independence Measure (FIM) on admission, weekly, and at discharge. For each group the averages of the length of stay (LOS), FIM score, and the efficiency ratio (ER) were obtained from the records. The ER is the difference of discharge to Admission FIM expressed as a fraction of the Length of Stay.

Results: There was significant difference ($p<0.0002$) among the five age groups for the means of ER for the male and female hypertensive and non-hypertensive patients together. The ER for patients below 60 years of age is found to be significantly higher than for patients over 60 years ($p<0.00001$). The means of the ER are 1.29, and 0.95 with the difference of 0.37 and its standard error of 0.108. Non-hypertensive patients had higher ER compared to the hypertensives for all the age groups (Tables 4a and 4b). This difference is significant for patients younger than 60 years ($p<0.01$) and older than 80 years ($p<0.00001$). ER for non-hypertensive patients below age 60 is significantly higher ($p<0.05$) than for the hypertensives. Among the patients over 60 years of age, there is no significant difference for the ER between non-hypertensives and hypertensives.

Conclusion: Younger non-hypertensive patients seem to show better progress with inpatient rehabilitation.

Keywords: stroke, hypertension, rehabilitation

Introduction

Stroke is a common cause of disability in the world.[1] Almost three-quarters of cases occur in low- to middle-income countries, leading to residual motor disabilities and intensive rehabilitation needs.[2,3] After stroke, many functions are affected, including both basic and instrumental daily living activities[2] and sensorimotor skills.[4] Lower extremity (LE) deficits are present in two-thirds of stroke patients, affecting motor control, gait, and balance, which in turn lead to poor quality of life and various degrees of dependence[5,6] , which in turn require effective treatment and are considered a priority in rehabilitation. Blood pressure (BP) elevation is commonly seen in up to 80% of patients after an acute ischemic stroke.[7] In a observational study, BP was evaluated in 560,000 patients with the systolic BP (SBP) being

>139 mmHg in 77% and >184 mmHg in 15% of patients on arrival at emergency department.[8] While BP is often reported to be higher in acute stroke patients with a history of hypertension than in those without hypertension, it is unclear whether reactive post-stroke hypertension is a pathophysiological response to maintain collateral circulation to ischemic penumbra or it represents a sign of severity of stroke. Data on the prognostic significance of BP control are still controversial. A recent study have shown no reduction in mortality or disability on Day 14 and at three months following stroke.[9] In another study, SBP below 101 and above 220 mmHg resulted in mortality rates higher than 40% and diastolic BP (DBP) of <61 mmHg or >120 mmHg resulted in mortality rates in over 45% of the patients.[10] Stroke is divided into three phases: acute, subacute and chronic phases considering BP changes in the natural course of stroke.[11] The acute phase is the first four days of the stroke episode in which great majority of patients show high BP. The subacute phase is the period from Day 4 to Day 10 after stroke. Blood pressure decline is usually seen during this period.

The chronic phase of stroke is considered to begin two weeks after the initial episode.[5] Management of elevated BP in subacute period is controversial due to the lack of reliable evidence from randomized-controlled trials.[12,13] Studies have traditionally focused on BP control within the first 24 to 48 hours after stroke. It is well-established that maximum neural recovery occurs within the first three months after stroke. Physiatrists have the unique opportunity to be care givers of stroke patients in this specific phase. During this period, the effect of BP on the neural recovery is investigated. Since hypertension is the major cause of strokes, in our study we have evaluated the effect of both age and hypertension on stroke patients using the Functional Independence Measure (FIM), a widely accepted functional outcome measure. We have examined the functional performance for both the hypertensive and non- hypertensive patients separately and for the male and female patients with or without hypertension.

Material and methods

This was retrospective observational study Department of Physical Medicine &Rehabilitation (PMR), Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India for 12 months, after taking the approval of the protocol review committee and institutional ethics committee. The data were collected from medical records of stroke patients who underwent inpatient rehabilitation during this period. Two hundred patients with thrombo- embolic strokes were included. The patients were divided into five age groups: below 50 years, 50-60 years, 60-70 years, 70-80 years and above 80 years. They were further classified into the hypertensive and non-hypertensive groups. The location of the lesion, time interval between the onset of stroke and transfer to rehabilitation, neurologic deficits, discharge destination, and gender were comparable among the groups. Patients with ischemic strokes from all age groups with or without hypertension are included. Patients had to complete their inpatient rehabilitation without interruption of their rehabilitation stay. Patients with hemorrhagic strokes and those with previous strokes and whose rehabilitation was interrupted from any medical complications were excluded. Patients' functional performance was assessed on the Functional Independence Measure (FIM) on admission, weekly, and at discharge. For each group the averages of the length of stay (LOS), FIM score, and the efficiency ratio (ER) were obtained from the records. The ER is the difference of discharge to Admission FIM expressed as a fraction of the Length of Stay. We considered that ER as the main functional outcome measure. Co-morbidity, medical complications and presence or absence of visuospatial deficits were also recorded. There were 200 patients 20 of them were under 50 years, 35 between 50-60 years, 50 between 60-70years, 70 between 70-80 and 25 were over 80 years of age. Comorbidities for the five age groups were depression; diabetes mellitus, coronary artery disease and congestive heart failure

were observed. There were 110 males comprising of 70 hypertensives and 40 non-hypertensives. 60 were hypertensive and 30 were non-hypertensive of 90 female patients. The admission (ADM) FIM, discharge (D/C) FIM, Length of Stay and Efficiency Ratios were individually tabulated under male, female hypertensive and non hypertensive groups and all male and all female groups in hypertensive and non- hypertensive categories were also studied.

Results

There were 110 males comprising of 70 hypertensives and 40 non-hypertensives. 60 were hypertensive and 30 were non-hypertensive of 90 female patients

Table 1 Demographics n=200

Age (years)	**Below -50**	**50-60**	**60-70**	**70-80**	**Above 80**
(n)	20	35	50	70	25
Male=110	9	21	30	38	12
Female=90	11	14	20	32	13
Lt. CVA	7	20	23	23	11
Rt. CVA	10	13	25	45	12
Br. Stem	3	2	2	2	2
Hypertensive=130	7	25	30	50	18
Non-hypertensive=70	13	10	20	20	7

Abbreviations CVA, cerebrovascular accident; BR, brain

Table 2A Male hypertensive n=70

Age (years)		**Below -50**	**50-60**	**60-70**	**70-80**	**Above 80**
(n)		4	16	15	28	7
A-FIM	Avg.	47.3	37.2	50.2	41.9	51.5
	St. Dev.	18.9	14.2	13.2	15.2	15.6
D-FIM	Avg.	69.8	65.8	72.8	65.8	72.3
	St. Dev.	18.9	17.9	13.8	17.9	10.9
LOS	Avg.	23.5	33.2	21.9	32.7	25.1
	St. Dev.	12.3	15.9	10.2	12.3	9.7
ER	Avg.	1.50	1.5	1.34	0.95	0.98
	St. Dev.	0.92	0.74	1.7	0.61	0.38

Table 2B Male non-hypertensives n=40

Age (years)		**Below -50**	**50-60**	**60-70**	**70-80**	**Above 80**
(n)		6	7	14	9	4
A-FIM	Avg.	45.5	47.7	40.3	45.5	39.4
	St. Dev.	20.5	13.8	11.3	14.9	8.7
D-FIM	Avg.	74.5	72.6	66.6	66.5	62.7
	St. Dev.	5.5	5.7	11.7	12.7	16.5

LOS	Avg.	32.5	25.9	30.4	24.9	30.5
	St. Dev.	105	279	11.8	11.5	10.4
ER	Avg.	0.95	1.07	1.1	1.11	0.97
	St. Dev.	0.42	0.91	0.51	0.72	0.65

Abbreviations A-FIM, admission functional independence measure; D-FIM, discharge functional independence measure; LOS, Length of Stay; ER, efficiency ratio

Table 3A Female hypertensives n=60

Age (years)		**Below -50**	**50-60**	**60-70**	**70-80**	**Above 80**
(n)		3	9	15	22	11
A-FIM	Avg.	48.6	38.5	49.6	42.8	50.9
	St. Dev.	19.4	13.8	12.9	14.8	15.2
D-FIM	Avg.	70.5	64.9	71.7	64.5	70.9
	St. Dev.	19.2	172	13.3	17.2	11.3
LOS	Avg.	22.8	32.8	22.2	31.8	24.5
	St. Dev.	12	15.6	9.5	13.6	9.4
ER	Avg.	1.41	1.2	1.31	0.87	0.92
	St. Dev.	0.88	0.71	1.4	0.57	0.41

Table 3B Female non-hypertensive n=30

Age (years)		**Below -50**	**50-60**	**60-70**	**70-80**	**Above 80**
(n)		7	3	6	11	3
A-FIM	Avg.	41.5	48.7	32.7	46.9	42.3
	St. Dev.	15.8	19.7	11.8	16.8	11.2
D-FIM	Avg.	75.7	69.5	57.8	67.6	63.7
	St. Dev.	14.3	14.4	15.9	14.8	15.2
LOS	Avg.	24.7	23.2	39.2	26.2	23.1
	St. Dev.	13.9	11.7	10.5	9.3	11.1
ER	Avg.	1.7	1.02	0.72	0.9	1.24
	St. Dev.	1.29	0.84	0.45	0.47	0.91

Table 4 All hypertensive n=130

Age (years)		**Below -50**	**50-60**	**60-70**	**70-80**	**Above 80**
(n)		7	25	30	50	18
A-FIM	Avg.	47.4	43.5	43.7	43.9	45.2
	St. Dev.	18.8	18.5	12.6	16.2	13.7
D-FIM	Avg.	71.9	69.1	68.4	65.3	66.9
	St. Dev.	15.7	17.9	12.6	17.4	14.5
LOS	Avg.	26.4	30.3	27.9	28.9	27.4
	St. Dev.	12.7	15.8	11.2	14.1	10.5
ER	Avg.	1.24	1.08	1.12	0.94	0.92
	St. Dev.	0.71	0.7	0.79	0.65	0.50

Table 4B All non-hypertensive n=70

Age (years)		Below -50	50-60	60-70	70-80	Above 80
(n)		13	10	20	20	7
A-FIM	Avg.	43.2	57.4	38.7	45.9	41.8
	St. Dev.	12.4	15.5	16.5	16.3	13.2
D-FIM	Avg.	75.9	77.3	58.8	67.5	66.8
	St. Dev.	10.7	10.2	17.9	14.1	14.3
LOS	Avg.	23.9	18.3	20.5	29.6	23.9
	St. Dev.	11.5	8.7	11.1	14.9	11.5
ER	Avg.	1.6	1.4	0.61	0.82	1.25
	St. Dev.	0.95	0.88	0.42	0.5	0.75

Table 5A Male hypertensive and non-hypertensive together n=110

Age (years)		Below -50	50-60	60-70	70-80	Above 80
(n)		9	21	30	38	12
A-FIM	Avg.	44.7	54.2	41.2	44.9	39.7
	St. Dev.	12.8	18.3	13.7	15.5	10.8
D-FIM	Avg.	75.5	76.6	64.7	67.2	64.8
	St. Dev.	5.2	13.8	14.8	13.2	15.9
LOS	Avg.	26.1	22.2	30.5	28.7	28.7
	St. Dev.	9.5	13.9	11.8	15.7	11.2
ER	Avg.	1.32	1.23	0.92	0.96	1.08
	St. Dev.	0.45	0.76	0.57	0.64	0.8

Table 5B Female hypertensive and non-hypertensive together n=90

Age (years)		Below -50	50-60	60-70	70-80	Above 80
(n)		11	14	20	32	13
A-FIM	Avg.	44.9	41.9	43.1	44.5	48.6
	St. Dev.	17.1	16.2	14.7	16.2	14.5
D-FIM	Avg.	73.6	66.7	66.5	65.9	68.9
	St. Dev.	16.5	16.5	15.7	17.8	12.4
LOS	Avg.	24.2	29.7	22.7	29.5	24.2
	St. Dev.	13.5	14.7	9.2	13.2	10.4
ER	Avg.	1.71	1.04	1.08	0.85	0.96
	St. Dev.	1.12	0.68	0.95	0.56	0.58

Table 6 Hypertensive and non-hypertensive males and females n=200

Age (years)		**Below -50**	**50-60**	**60-70**	**70-80**	**Above 80**
(n)		20	35	50	70	25
A-FIM	Avg.	44.8	49.5	41.9	44.7	44.2
	St. Dev.	15.2	18.5	14.2	16.2	13.5
D-FIM	Avg.	74.3	72.5	65.5	66.7	66.9
	St. Dev.	12.8	15.8	15.2	15.7	14.5
LOS	Avg.	24.9	25.2	30.2	28.8	26.5
	St. Dev.	11.8	14.5	12.6	14.5	10.4
ER	Avg.	1.55	1.17	0.97	0.92	1.2
	St. Dev.	0.92	0.76	0.75	0.55	0.56

Table 7 Analysis of variance (ANOVA). F- ratio and p-value

	Males		**Females**		**Males and females**	
Hypertensive	n = 70		n = 60		n = 130	
	F	p	F	p	F	p
A-FIM	1.07	0.4	1.61	0.21	0.3	0.96
D-FIM	1.21	0.32	0.70	0.55	0.55	0.68
LOS	0.92	0.51	2.37	0.07	0.4	0.91
ER	0.1	0.97	1.51	0.27	0.95	0.45
Non-hypertensive	n = 40		n = 30		n =70	
	F	p	F	p	F	p
A-FIM	2.81	0.03	1.72	2.61	4.29	0.003
D-FIM	4.51	0.004	1.95	0.14	5.95	0.0002
LOS	3.89	0.007	0.44	0.81	3.55	0.01
ER	4.47	0.003	44	0.006	8.14	0.00005
Hypertensive and						
Non-hypertensive	n = 110		n = 90		n = 200	
	F	p	F	p	F	p
A-FIM	4.18	0.0032	0.54	0.72	1.65	0.17
D-FIM	4.52	0.002	0.79	0.54	3.21	0.0141
LOS	2.02	0.09	2.44	0.05	1.77	0.14
ER	2.05	0.09	3.97	0.004	5.31	0.0004

Table 8 Correlation of (r) age and ER and Student's t

	Males		**Females**		**Males and females**	
Hypertensive						
	n = 70		n = 60		n = 130	
	r	t	r	t	r	t
	-0.09	-0.77	-0.21	-0.17	-0.15	-1.91
Non-hypertensive	n = 40		n = 30		n = 70	
	r	t	r	t	r	t
	-0.3	-2.5	-0.48	-3.8	-0.39	-4.4
Hypertensive and Non-hypertensive	n = 110		n = 90		n = 200	
	r	t	r	t	r	t
	-0.2	-2.45	-0.35	-3.98	-0.25	-4.6

In this study, the differences among the averages of the five age groups for each of the four functional measures A-FIM, D-FIM, LOS and ER are statistically analyzed. The evaluation is conducted separately for the male-female and hypertensive-non-hypertensive groups. The Analysis of Variance (ANOVA) method, F-ratios and Student's t-tests were employed for the statistical evaluation. The ANOVA is an extension of the Student's t-test employed to examine the hypothesis related to the differences among the means of more than two groups. The effect of age is further examined from its correlation with ER. Correlation significantly different from zero indicates difference of ER among the age groups. Examining this correlation is statistically equivalent to the evaluation of the relation between ER and age through regression analysis.
The averages and standard deviations of the four functional measures appear in (Tables 2) (Tables 3) (Tables 4) (Tables 5) (Tables 6). The F-ratios and p-values for the ANOVA tests are presented in Table 7. The correlations of age with ER along with the corresponding values of the Student's t are presented in Table 8. The following observations are made from all these tables, from (Tables 7) (Tables 8).

Age: There is a significant difference ($p<0.0002$) among the five age groups for the means of ER for the male and female hypertensive and non-hypertensive patients together. The ER for patients below 60 years of age is found to be significantly higher than for patients over 60 years ($p<0.00001$). The means of the ER are 1.29, and 0.95 with the difference of 0.37 and its standard error of 0.108. Non-hypertensive patients had higher ER compared to the hypertensives for all the age groups (Tables 4a and 4b). This difference is significant for patients younger than 60 years ($p<0.01$) and older than 80 years ($p<0.00001$).

Hypertension: ER for non-hypertensive patients below age 60 is significantly higher ($p<0.05$) than for the hypertensives. Among the patients over 60 years of age, there is no significant difference for the ER between non-hypertensives and hypertensives, (Tables 2A), (Table 2B) and (Tables 3A), (Table 3B).

The average lengths of stay (LOS) for the five age groups were 25, 25, 30, 29 and 26 days, respectively. The mean efficiency ratios for the groups were 1.55, 1.17, 0.97, 0.92 and 1.2 respectively (see Table. 6). The difference of the average ER among the five age groups is significant for the non-hypertensive males as well as for females. The hypertensive patients' LOS in general is longer compared to non- hypertensives. The average ER for the age groups

60-70 and 70-80is less than one but>1 for the remaining three age groups. The ADM and D/C FIM scores were lower for the non hypertensives for the 60-70 group to account for the lower ER. For the hypertensive males and females, the differences among the means for the functional measures are not significant. These results may be attributed to either stable hypertension or better management of hypertension during their rehabilitation stay.The male non-hypertensives, the difference among the means is significant for each of the four functional measures; p<0.02 for A-FIM and<0.007 for the remaining three measures. the female non-hypertensives, the difference among the means of the age groups is significant only for the ER (p< 0.007), but not for the remaining three measures (Tables 7). The 60 -80 year- old (male and female) non-hypertensives, the LOS is longer relative to the remaining four age groups. For the (60-70 age group) male non-hypertensives, the FIM gain is smaller relative to the remaining four age groups. These are the two reasons for the significant differences in (a) and (b) for the ERs of both males and females (Table 2B).For the male as well as female non-hypertensives in the age groups (60-70) and (70-80), the LOS is longer relative to the other three groups (Table 2B) & (Table 3B), resulting in the ER<1 compared to>1 for the other age groups. The male and female hypertensives, the differences among the age groups are not significant for the four functional measures, especially the ER. It is only slightly significant for the LOS of the female hypertensives (p< 0.08) (Tables 7).

The correlations of ER with age are negative for the male-female as well as the hypertensive-no hypertensive groups (see Table 8), that is, ER decreases with age for all these categories. Further, the decrease of ER with age is significant for the non-hypertensive males as well as females. Similar results can be expected from the regression of ER on age.

Discussion

This study attempted to discriminate between the influence of age and factors associated with age on functional outcome. Age alone shows a significant (*P*_0.001) but small effect on functional outcome when outcome is measured as FIM score at discharge or Motor FIM score at discharge. Advanced age, however, appears to have no effect on the very important outcome of change in FIM score. These results are in agreement with others that show that both functional status at admission and age are significant prognostic factors.[14,15] Age has an insignificant clinical impact, however, as indicated by the small variation in outcome (~1%) that can be attributed solely to age.

Effect of hypertension and its impact on an individual's outcome measured in FIM scale has not been studied previously. Our study examined the presence or absence of hypertension and its impact retrospectively and found that presence of hypertension itself had a clear impact on the functional outcome as measured by ER. It is significantly higher for the non-hypertensive patients in the younger age groups (n=32) vs 23 patients under 60 years of age (2.69 vs 1.21). Hypertension did not affect functional progress of stroke patients(n=80) between 60-80 years of age The possible explanation is that older individuals are more likely to have pre-existing disease and disabilities which may have effects on their functional recovery. It is possible that other factors such as co-morbidities may have had a stronger impact on functional recovery in older age groups, and thus presence or absence of hypertension did not make a significant difference in those groups. There is no consensus on the influence of age on the outcome of rehabilitation after stroke. Most studies in the literature showed negative outcomes with increasing age. A few studies pointed out the absence of the effect of age on the outcomes. Earlier studies reflected utilizing the Barthel index to measure functional progress of patients in rehabilitation settings. Our study showed that patients younger than 60 years of age with no history of hypertension had better progress in rehabilitation. This group of 47

patients with no hypertension showed better functional performance on FIM scores and ER. Also the oldest group of 25 patients >80 years have shown better functional outcomes in this study. The FIM is a widely accepted functional outcome measure, currently used in the rehabilitation units across the US. In a Meta-analysis of 11 studies by Ottenbacher and Granger,[16] the FIM instrument demonstrated acceptable reliability across a wide variety of settings, raters, and patients. The study by Bagg et al.[17] found that advanced age had no effect on the FIM scores. In their sample of 561 patients age is reported to be a significant prognostic factor for acute and long-term mortality and functional recovery. The study by Adler[18] suggested that compared to younger patients, older individuals may have more severe deficits from strokes and hence do less well. As age advances, cognitive skills may also decline. In our study, we had excluded patients with dementia or cognitive deficits.

It was also postulated by some researchers that older brains may intrinsically have less ability to recover, although the elderly may be more likely to employ compensatory strategies to overcome some of the neural impairment that remains after stroke. More studies are required to show that age itself is not a factor in determining the outcome after stroke. Research also needs to focus on patients older than 80 years.

The clinical impact of this study is enormous when the stroke statistics are taken into consideration. Every year about 140,000 Americans die from stroke. In 2016, stroke accounted for about one out of every 19 deaths in the US. Every 40 seconds, someone in the United States has a stroke and there is a death every 4 minutes from stroke.[19] Stroke risk varies by age. In 2009, 34% of people hospitalized for stroke were less than 65 years old.[20] Stroke reduces mobility in more than half of stroke survivors age 65 and over.[21] Memis and colleagues[22] found in their study that age had noeffect on functional status and disability of stroke patients.

Feigin et al[23] described the global impact of stroke and its consequences emphasizing the need for more efficient prevention strategies. Hypertension being the major contributor for the disease, our study evaluated its impact especially on functional outcomes.
The limitations of the study are that it is a retrospective analysis and we were unable to find how many of the hypertensives had swings or variability of their blood pressures and whether they were symptomatic from it during rehabilitation. Patients' admission blood pressures and their effect on the participation in therapies were not reported. The collection of the FIM scores to assess maintenance of the functional gains at 3 months and at one year would have been helpful to determine the influence of age and hypertension in this population. Future studies are needed to study the impact of the variations in blood pressure of stroke patients during rehabilitation and their functional gains.

Conclusion

Stroke Patients younger than 60 years of age with no hypertension showed better progress with inpatient rehabilitation as measured on the Functional Independent Measure in our retrospective study of 200 subjects.

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