Original Article

Functional recovery and blood pressure on acute post-stroke setting

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ABSTRACT

Objectives: This study aims to evaluate the effects of blood pressure (BP) on functional recovery and length of stay (LOS) in post-stroke patients in an acute rehabilitation facility (ARF).

Patients and methods: A total of 116 ischemic stroke patients (60 males, 56 females; mean age 70.0±12.8 years; range, 37 to 93 years) who were admitted to the ARF between January 2012 and September 2012 were included. Daily BP measurements with mean systolic and diastolic BP values and Functional Independent Measure (FIM) scores at the time of admission and discharge were measured. The LOS and systolic and diastolic BP ranges were also recorded.

Results: There was no significant correlation between the BP and FIM scores. The mean diastolic BP was positively correlated with admission (rs=0.316, p=0.01) and discharge (rs=0.287, p=0.002), FIM scores, and FIM effectiveness (rs=0.185, p=0.047) and negatively correlated with age (r=-0.449, p<0.001) and LOS (rs=-0.189, p=0.042). The LOS in hospital was negatively correlated with FIM scores at admission (rs=-0.585, p<0.001) and discharge (rs=-0.352, p<0.001) and positively correlated with FIM score changes (rs=0.414, p<0.001).

Conclusion: Our study results show that diastolic BP in the subacute phase of stroke does not have a major impact on the functional recovery and LOS in post-stroke patients. However, there is a significant correlation between diastolic BP values and FIM efficiency.

Keywords: Acute rehabilitation unit, blood pressure, functional recovery, motor recovery, stroke.

Blood pressure (BP) elevation is commonly seen in up to 80% of patients after an acute ischemic stroke.[1] 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.[2] 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.[3] 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.[4]

Stroke is divided into three phases: acute, subacute and chronic phases considering BP changes in the natural course of stroke.[5] 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.[6,7] 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.

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In the present study, we hypothesized that lower BP readings would adversely affect the short-term outcomes in terms of motor recovery and length of stay (LOS) in acute stroke patients and, consequently the functional gains made in an acute rehabilitation setting. Therefore, we aimed to evaluate the effects of BP on functional recovery measures and LOS after ischemic stroke in an acute rehabilitation facility (ARF).

PATIENTS AND METHODS

This study included a total of 116 ischemic stroke patients (60 males, 56 females; mean age 70.0±12.8 years; range, 37 to 93 years) who were admitted to the University of Minnesota, Medical School, Acute Rehabilitation Center between January 2012 and September 2012. Hemorrhagic stroke patients were excluded from the study. Data including age, sex, side of stroke, clinical manifestations, and Functional Independence Measure (FIM) scores at the time of admission and discharge and change in the FIM scores were recorded. Other measures included were mean SBP and DBP values with antihypertensive medications. As the BP can be affected by renal function and cardiac status, we included creatinine levels as well as ejection fraction during evaluation.

During the inpatient stay in the ARF, BP was measured by nursing staff using a standard mercury sphygmomanometer (W.A. Baum Co., Inc., Copiague, New York, USA) with the patients in a supine position, and disappearance of the Korotkoff phase-5 sound was defined as DBP. The BP was recorded on the non-hemi paretic arm. We calculated the mean of all BP readings (recorded every 12 hours per 24 hours) in the ARF (including admission and discharge BP). The majority of the patients were on antihypertensive medications, except for 15 patients who were not on antihypertensives due to inpatient hypotension or lower BP range necessitating the need to discontinue the medications.

Physical and cognitive disability was evaluated using the FIM scale.[8] The FIM scale measures the level of a patient's disability and indicates the assistance that would be needed to perform a specific task. We used FIM effectiveness, which was measured as; change in FIM score during rehabilitation/(126 - FIM score at admission to rehabilitation)×100.[9] A written informed consent was obtained from each patient. The study protocol was approved by the Institutional Review Board of University of Minnesota, Faculty of Medicine. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical analysis

Statistical analysis was performed using the SPSS version 15.0 software (SPSS Inc., Chicago, IL, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency. After normal distribution was checked using the Kolmogorov-Smirnov test, the Student's t-test was used to compare mean values of clinical variables (patients with neglect vs. without neglect). Correlations between the demographic and clinical characteristics were analyzed using the Pearson (r) and Spearman's (rs) correlation coefficients, where appropriate. A *p* value of <0.05 was considered statistically significant.

RESULTS

The mean LOS in the ARF was 6.5±7.2 days after stroke. A total of 18 patients had bilateral, 37 patients had right-sided, and 61 patients had left-sided ischemic

Table 1. Demographic and clinical characteristics of patients

	Mean±SD	Median	Min-Max
Age (year)	70±12.8		
Hospitalization after stroke (day)	6.5±7.2		
Admission functional independence measure		67	31-118
Discharge functional independence measure		93	39-123
Functional independence measure change		19	-19-58
Length of stay (day)		10	1-32
Systolic blood pressure mean (mmHg)	129.5±12		
Diastolic blood pressure mean (mmHg)	73.6±7.7		
Number of drugs		2	0-5

SD: Standard deviation; Min: Minimum; Max: Maximum.

Table 2. Correlations between BP and FIM scores

	BPS min	BPS max	BPS mean	BPD min	BPD max	BPD mean
Age	-0.136	0.034	-0.010	-0.532*	-0.167	-0.449*
FIM at admission	0.273*	0.023	0.143	0.321*	0.027	0.316*
FIM at discharge	0.189**	-0.046	0.084	0.352*	0.021	0.287*
FIM change	-0.095	-0.066	-0.073	0.021	-0.006	-0.001
FIM effectiveness	0.074	-0.094	0.001	-0.032	0.227**	0.185**
Length of stay	-0.264**	0.083	-0.036	-0.214**	0.030	-0.189**

BP: Blood pressure; FIM: Functional independence measurement; BPS: Blood pressure systolic; BPD: Blood pressure diastolic; Min: Minimum; Max: Maximum; * Correlation is significant at 0.01 level; ** Correlation is significant at 0.05 level.

stroke. Table 1 shows demographic and clinical characteristics of the patients.

No strong correlation was found between the BP and FIM scores. The mean DBP was positively correlated with admission (rs=0.316, p=0.001) and discharge (rs=0.287, p=0.002), FIM scores, and FIM effectiveness (rs=0.185, p=0.047) and negatively correlated with age (r=-0.449, p<0.001) and LOS (rs=-0.189, p=0.042) (Table 2). The LOS in hospital was negatively correlated with the FIM scores at admission (rs=-0.585, p<0.001) and discharge (rs=-0.352, p<0.001) and positively correlated with the FIM score changes (rs=0.414, p<0.001).

The patient's age was negatively correlated with admission (rs=-0.260, p=0.005) and discharge (rs=-0.310, p=0.001) FIM scores, indicating that age was a negative prognostic factor in the recovery of stroke.

Of 116 patients, 18 were neglected. Comparing patients with and without neglect, both had similar FIM scores at admission (64 [35-99] vs. 68 [31-118] [p=0.219]); however; those with neglect had lower FIM scores at discharge (79 [46-114] vs. 94 [39-123] [p=0.042]).

DISCUSSION

In this study, we evaluated the effect of BP on functional recovery as measured by FIM scores and subsequent LOS of ischemic stroke patients in an ARF setting. Although we were unable to find correlation between BP and FIM scores, based on cross-sectional data analysis, we found that the mean DBP was positively correlated with the admission and discharge FIM scores, and FIM effectiveness. The mean DBP was, however, inversely associated with age and LOS. Age was also negatively correlated with admission and discharge FIM scores, and FIM effectiveness. Furthermore, the patients with neglect had lower FIM scores at discharge.

In the literature, there is conflicting evidence regarding the effects of elevated BP on stroke outcome. Several studies have shown a poor prognosis,[10-14] while others have suggested a favorable prognosis.[15,16] In our study, we found positive correlation between the mean DBP and FIM scores at admission and discharge only in the cross-sectional data analysis, and this finding supports the hypothesis of our study. Previous studies in the literature primarily have investigated the effect of BP changes on functional recovery, particularly in acute phase[10,11,13] or chronic phase of stroke. In a study by Kang et al.,[17] they examined the effect of BP in subacute period (median interval from onset to discharge was 8.7 days). The authors found that patients with poor outcome had higher BP levels, except for the mean DBP, and also these patients had a wider range of BP variability than those with improved outcomes. In our study, the mean DBP was positively correlated with admission and discharge FIM scores and FIM effectiveness during the subacute period.

Studies by Ng et al.[18] and Gialanella et al.[19] showed that admission FIM scores were significant functional outcome predictors. In this study, the patients with higher admission FIM scores had shorter LOS period in hospital. Our results are consistent with the relevant literature data.

In our study, the age of the patients was negatively correlated with admission and discharge FIM scores and mean DBP values. Our results regarding the age are consistent with the Macciocchi et al.'s[20] results, but are in contrast to those reported by Kong et al.[21] Despite some inconsistencies in the existing literature, age was associated with poorer functional scores in our study. Advanced age probably plays a role in terms of medical comorbidities and increased psychosocial problems and physical impairment.[22]

Furthermore, neglect is well known to contribute to disability due to its negative effect on balance, visual perception, mobility, skin, and joint protection.[22] In our study, the patients without neglect showed higher FIM scores at discharge than those with neglect. This finding is consistent with the relevant literature evaluating the impact of neglect in acute phase[23] and beyond acute phase.[24-26] Also, Katz et al.[24] showed that neglected patients had lower total, motor, and cognitive FIM scores than those without neglect. Neglect has been also shown to be associated with lower performance on measures of disability as well as impairment.

Nonetheless, this study has some limitations. First, the treatment plan of the patients for BP (decrease as well as increase) was not standardized, resulting in different treatment regimens for patients with similar BP values. Also, strict regulation of BP at the acute phase of stroke might have affected the results, which is beyond our control. Second, possible confounders such as stroke localization, size of the infarct, initial severity of stroke and medical comorbidities might have likely affected the outcome. Third, we recommend a longer follow-up after discharge from the ARF setting rather than the average LOS that the patients were followed. Finally, as there is no optimal method to elucidate the BP well, we believe that the results of calculating the mean of the BP values might have lessened the impact of the present study.

In conclusion, this study has brought to the forefront the question of optimal BP control to maximize motor recovery in a period specific interest to physiatrists. In our study, increased DBP was found to be associated with improved functional recovery only through cross sectional data analysis. These data highlight the importance of BP control in the comprehensive rehabilitative management program following stroke. Further large-scale and long-term studies are needed to elucidate the possible causative relationship on this topic.

Declaration of conflicting interests

Funding

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