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# Impact of Arterial Blood Pressure Management in Acute Ischemic Stroke on Short Term Outcome and Prognosis

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## ABSTRACT

**Background:** Blood pressure (BP) is elevated in 75% or more of patients with acute stroke and is associated with poor outcomes. Whether to modulate BP in acute stroke has long been debated. With the loss of normal cerebral autoregulation, theoretical concerns are twofold: high BP can lead to cerebral edema, hematoma expansion or hemorrhagic transformation; and low BP can lead to increased cerebral infarction or perihematomal ischemia.

**Objective:** To determine the impact of arterial blood pressure management in acute ischemic stroke on short term outcome and prognosis. **Patients and methods:** This study included 200 patients diagnosed with ischemic stroke and arrived to Emergency Hospital, Mansoura University over a year from June 2019 to June 2020. The cases were classified into 4 groups according to the systolic BP (SBP) of the cases; control group (SBP < 140 mmHg), group 2 (SBP 140-160 mmHg) group 3 (SBP 160-180 mmHg) and group 4 (SBP 180-200 mmHg).

**Results:** The stroke score (follow up) according to blood pressure groups showed no statistically significant difference between the groups. Regarding the initial CT findings of the cases according to blood pressure groups, fourth group has more changes in CT brain, with a highly statistical significant difference observed between the groups.

**Conclusion:** Elevated blood pressure in patients with stroke were associated with worse outcomes including ICU admission, mortality and duration of hospital admission. CT findings supported these findings as the percent of cases presented with initial infarction and cases who showed hemorrhagic transformation increased with elevation of BP.

**Keywords:** Arterial Blood Pressure, Acute Ischemic Stroke, CT, ICU.

## INTRODUCTION

Stroke is a non-traumatic vascular insult of the brain in which poor blood flow to the brain results in cell death. It is a major public health problem and the second leading cause of death and long-term disability all over the world [(1)].

Number of potential causes have been hypothesized, including preexisting hypertension; infection; pain; stress associated with hospitalization; activation of neuro-endocrine hormones (cortisol, natriuretic peptide and renin-angiotensin-aldosterone) and sympathetic neuroendocrine systems; reduced cardiac baroreceptor sensitivity; and Cushing's reflex (a vasopressor response in response to increased intracranial pressure) [(2)]. Large vessel occlusion (LVO) leading to severe acute ischemic stroke and vessel rupture leading to acute hemorrhagic stroke and intracerebral hemorrhage (ICH) are immediately threatening the patient with severe disability or even death. The emergency and critical care management of these patient naturally involves controlling circulation including BP. Physicians may have tended to raise BP (or leave high BP alone) in acute ischemic stroke and lower BP in ICH [(3)]. Blood pressure is one of the vital signs, along with respiratory rate, heart rate, oxygen saturation and body temperature. Normal resting blood pressure in an adult aged (18-60) is approximately 120 millimeters of mercury systolic, and 80 millimeters of mercury diastolic, abbreviated "120/80 mmHg". Globally, the average age standardized blood pressure has remained about the same since1975 to present, at approx. 127/79 mmHg in men and 122/77 mmHg in women [(4)]. Blood pressure could be an important modifiable factor associated with functional outcomes, especially when considering acute stroke management. Elevated BP in acute periods is associated with worse outcomes in acute ischemic stroke (AIS) and could also influence the clinical outcome of patients after reperfusion therapy [(5)]. Mean arterial pressure is the strongest predictor of stroke and is important for maintaining cerebral perfusion and cerebral blood flow velocity [(6)]**.** High blood pressure during the acute phase of ischemic stroke might be advantageous, as it may improve cerebral perfusion of the ischemic tissue. Conversely, elevated blood pressure might also be detrimental, as it can exacerbate edema and hemorrhagic transformation of the ischemic tissue [(7)].

The aim of our study was to determine the impact of arterial blood pressure monitoring in acute ischemic stroke on short term outcome and prognosis.

## PATIENTS AND METHODS

This is a prospective observational study, which was carried out on 200 patients that diagnosed with ischemic stroke and arrived to Emergency Hospital, Mansoura University over a year from June 2019 to June 2020.

**Inclusion criteria:** The study included 200 patients arrived to Emergency Department (ED) and treated by members of ED: Aged 18 or older, first-ever ischemic stroke confirmed by a CT and both gender.





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**Exclusion criteria:** Aged less than 18, pregnancy, acute heart failure, acute coronary event in the last 3 months, previous intracranial hemorrhage, previous ischemic stroke, thrombocytopenia (less than 100.000/$mm^3$), renal failure and major surgery within last 6 weeks.

**All patients were subjected to the following:**

1. **History taking:** Personal history, present history and past medical history.
2. **Examination:**
   - **A- General:** Level of consciousness according to GCS, blood pressure, heart rate and respiratory rate and urine output.
   - **B- Regional:** Head and neck, chest examination, heart sounds, abdominal examination and extremities examination.
   - **C- Neurological:** Mental status examination, cranial nerve examination, motor system, deep tendon reflexes, sensation, cerebellum and stroke score.
3. **Investigations:**
   - **A- Laboratory:** Complete blood count, arterial blood gases, serum potassium and serum sodium, liver functions and renal function.
   - **B- Radiology:**
     - CT brain: to reveal ischemic changes, hemorrhagic changes, space occupying lesion (SOL) as abscess or tumors.
     - ECG: any type of arrhythmia
4. **The studied patients were classified into 4 groups (50 each):**

- Control group: the blood pressure range (110/70 – 140/80)
- Second group: the blood pressure range (140/80 – 160/90)
- Third group: the blood range (160/90 – 180/100)
- Fourth group: the blood range (> 180/110 )

5. **Management:** conservative.

**Ethical consideration:**

Informed written consent was obtained from the patients sharing in the study or their relatives. Confidentiality and personal privacy were respected in all levels of the study. Collected data will not be used for any other purpose. **An approval of the study was obtained from Mansoura University academic and ethical committee.**

**Statistical analysis:**

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Wilk test. Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi^2$) was used to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation), median, and range. Paired t-test was used to compare between two paired means and one way ANOVA was used to compare more than 2 means of normally distributed variables (parametric data). P value < 0.05 was considered significant.

**RESULT**

The age of the patients ranged from 30 to 95 years. 53% of the cases were males (Table 1).

**Table (1):** Demographic data of cases included in study

| | Variable | Study cases (N=200) | |
|---|---|---|---|
| **Age:** | Mean ± SD | 59.61 ± 16.25 | |
| | Median (Min-Max) | 56 (30-95) | |
| **Gender:** | | **Number** | **Percentage** |
| | Male | 106 | 53% |
| | Female | 94 | 47% |

There were statistically significant difference observed between initial and follow up stroke score. (Table 2).

**Table (2):** Comparison of stroke score and blood pressure (Initial and at follow up)

| Variable | Initial (N=200, 100%) | Follow up (N=174, 87%) | P |
|---|---|---|---|
| **Stroke score**<br>Mean ± SD<br>Median<br>(Min-Max) | <br>7.04 ± 1.46<br>7<br>(3 - 9) | <br>6.02 ± 1.85<br>6<br>(1 - 9) | < 0.001* |
| SBP (mmHg)<br>Mean ± SD | 132.57 ± 27.15 | 136.51 ± 29.07 | 0.106 |
| DBP (mmHg)<br>Mean ± SD | 83.64 ± 13.48 | 84.94 ± 14.56 | 0.129 |

*: statistically significant SBP: Systolic blood pressure DBP: Diastolic blood pressure #13% mortality rate

Regarding the initial CT findings of the cases according to blood pressure groups, fourth group had more changes in CT brain, with a highly statistical significant difference observed between the groups. Hemorrhagic transformation was significantly more in patient with high BP in 4th group. According the improvement of cases the control group and the 2nd group had more statistically significant improvement compared to other groups. Regarding the ICU admission of the cases according to blood pressure groups, the fourth group had statistically more ICU admission than other groups. The control group and the second group had statistically more survival cases than the others (Table 3).

**Table (3):** Comparison of demographic data, initial stroke score, stroke score (follow up), initial CT findings, follow up CT findings, improvement, ICU admission and survival according to blood pressure groups

| Groups / Parameter | Control (N=50) | 140-160 mmHg (N=50) | 160-180 mmHg (N=50) | 180-200 mmHg (N=50) | P |
|---|---|---|---|---|---|
| **Age (years)** | 59.52 ± 16.71 | 57.66 ±15.11 | 62.06±18.16 | 59.18 ± 15.02 | 0.598 |
| **Sex:** | | | | | |
| Males | 27 (54%) | 26 (52%) | 27 (54%) | 26 (52%) | 0.994 |
| Females | 23 (46%) | 24 (48%) | 23 (46%) | 24 (48%) | |
| **Initial stroke score** | 7 ± 1.50 | 7.14 ±1.57 | 7.2 ±1.39 | 7.17 ± 1.45 | 0.493 |
| **Stroke score (follow up)** | 5.70 ± 1.64 | 5.70 ± 2.10 | 6.49 ± 1.82 | 6.24 ± 1.77 | P= 0.911 |
| **Initial CT findings:** | | | | | |
| Free | 42 (84%) | 38 (76%) | 35 (70%) | 31 (62%) | 0.086 |
| Infarction | 8 (16%) | 12 (24%) | 15 (30%) | 19 (38%) | |
| **Follow up CT findings:** | | | | | |
| Hemorrhagic transformation | 1 (2%) | 7 (14%) | 8 (16%) | 11 (22%) | 0.001* |
| No changes | 47 (94%) | 31 (62%) | 31 (62%) | 27 (54%) | |
| New infarction | 2 (4%) | 12 (24%) | 11 (22%) | 12 (24%) | |
| **Improvement:** | | | | | |
| Improved | 40 (80%) | 38 (76%) | 28 (56%) | 26 (52%) | < 0.005 |
| Not-improved | 10 (20%) | 12 (24%) | 22 (44%) | 24 (48%) | |
| **ICU admission:** | | | | | |
| No | 34 (68%) | 33 (66%) | 23 (46%) | 20 (40%) | <0.008* |
| Yes | 16 (32%) | 17 (34%) | 27 (54%) | 30 (60%) | |
| **Survival:** | | | | | 0.513* |
| Survived | 46 (92%) | 44 (88%) | 43 (86%) | 41 (82%) | |
| Died | 4 (8%) | 6 (12%) | 7 (14%) | 9 (18%) | |

Continuous data expressed mean ±SD Categorical data expressed as Number (%)

## DISCUSSION

In the current study, the mean age of the cases is 59.61 and 53% of the cases were males. There is a slight male predominance among the cases included in our study. Similar data were revealed in a recent Egyptian study conducted by **Soliman *et al.*[8]** who included one hundred sixty-seven patients with acute ischemic stroke were included in this cross-sectional descriptive study. Their age ranged from 15 to 90 years, with mean and standard deviation of 59.3 ± 13.45 years. In 90 males (53.9%), 11 patients of them were ≤ 45 years old, and in 77 females (46.1%), 13 patients of them were ≤ 45 years old.

Regarding the age of the cases, the current study is in agreement to the previous studies showing that incidence of ischemic stroke increased with advancing age. In **Marwat *et al.*'s [9]** study, incidence of ischemic stroke increased with advancing age where 2.3% in the age group 40–50, 27.2% in the age group 51–60, and 47.7% in the age group older than 60 years. Also, in **Grau *et al.*'s [10]** study, ischemic stroke increased with advancing age where 5.7% of the patients were < 45 years and 94.3% of the patients were ≥ 45 years.

Our results came in agreement with **Zafar *et al.* [11]** who showed that men were at greater risk for ischemic stroke than female. This can be explained by the hormonal constitutional factors plus the higher rate of smoking and higher rate of stressful situations among males than females [12].

In the current study, regarding the blood pressure, the mean of initial SBP and DBP were not statistically significantly different from the mean of follow up. This agreed with **Jain *et al.* [13]** who included 241 patients with acute ischemic stroke in their study. 87.5% of the patients had hypertension on admission; seventy-two patients (29.86%) had grade I hypertension, 48 patients (19.9%) had grade II hypertension, and 90 patients (37.34%) had grade III hypertension. With follow up, the authors showed that the 223 patients who did not receive antihypertensive medications in the first 24 hours achieved 38.36% and 57.1% of the total reduction in the SBP, 73.57% and 78.09% of the total reduction in the DBP and 55.48%

and 73.87% of the total reduction in the MBP by the first 12 and 24 hours respectively.

On the other hand several studies have documented that blood pressure is frequently elevated in the first day after onset **Leonardi-Bee *et al.* [14] and Toyoda *et al.* [15]**. Also in a study of over 500,000 patients with stroke by **Qureshi *et al.* [16]**, 77% of the 276,734 patients with verified ischemic strokes displayed systolic blood pressures (SBP) >140 mmHg at the emergency department.

Blood pressure elevations in acute stroke may be mediated by a variety of mechanisms, including pre-existing hypertension, but also stress associated with the acute illness and hospitalization, increased sympathetic drive with catecholamine and cortisol release, activation of the rennin-angiotensin aldosterone system, and the Cushing reflex in cases of markedly increased intracranial pressure due to intracerebral hematoma or edema[17].

In the current study, the initial stroke score was statistically significantly different from follow up score. This in agreement with **Jain *et al.* [13]**, who showed that the initial score among the cases included in their study was 22.98±10.38 and with follow up the authors reported a decrease of the score to reach 22.98±10.38 with high statistically significant difference between the two values.

In the current study, regarding the CT findings of cases in this study, the incidence of initial infarction or development of new infarction areas increased with the increase in SBP at admission. Similar results were reported by **Nasi *et al.* [18]** who included total of 218 patients with acute ischemic stroke who were allocated to one of the three SBP ranges as 77 in Group 1 (140–160 mmHg), 75 in Group 2 (161– 180 mmHg), and 66 in Group 3 (181–200 mmHg). Approximately one third of patients in each group had large infarcts involving greater than 1/3 distribution of the MCA territory, and strokes of anterior circulation were the most frequent.

Regarding the final outcomes of cases included in study, 57 % improved and 87% survived while. This is agreement with **Bager *et al.* [19]** who reported that among 799 patients included in their study, 70 (8.8%) patients had died at 1-month follow up. Both SBP and MAP displayed significant association with short term mortality whereby BP decrease on arrival to the ward was associated with lower mortality.

In the current study, the stroke severity score at admission and with follow up increased with the increase in the initial BP to reach the highest value in group 3 and decreased again in group 4. However, the difference didn't achieve a statistically significant value. This is agreement with **Soliman *et al.* [8]** who showed that NIHSS score was significantly higher in hypertensive patients (P value = 0.023). The authors also showed that ischemic stroke disability at presentation using MRS; where MRS was significantly higher in hypertensive patients compared to non-hypertensive patients (p value <0.001).

In the current study, regarding the survival of the cases according to blood pressure groups, there was a significant increase in the incidence of mortality with increasing the blood pressure at admission. These findings are in agreement with **Bager *et al.*[19]** who showed that there is a protective effect of larger BP decreases as well as higher admission BP, where larger BP decrease is associated with lower mortality and higher admission BP is associated with better functional outcome.

Within the same context, **Nasi *et al.* [18]** showed that there was a higher proportion of 90-day good outcome in groups 1 and 2, as compared to group 3, but these differences were not statistically significant. Moreover, there was no difference in mortality across all three groups but the greatest frequency of symptomatic intracranial hemorrhagic was in patients allocated to the higher range target. There were no differences in good outcome among the three groups in patients with baseline SBP $<$ or $\geq$ 160 mmHg. Also **Wohlfahrt *et al.* [20]**, noted that there is an association between lower BP and death. A meta-analysis of several relatively small studies, investigated the association between outcome in acute ischemic stroke and BP measured by ambulatory monitoring methods during the first 24 hr of admission and found that elevated pressures predicted poor outcome, in the form of either death or poor functional outcome.

## CONCLUSION

Elevated blood pressure in patients with stroke were associated with worse outcomes including ICU admission, mortality and duration of hospital admission. CT findings supported these findings as the percent of cases presented with initial infarction and cases who showed hemorrhagic transformation increased with elevation of BP.

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