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Hypertensive and Non-hypertensive Hospital Admission Blood Pressure Association with Cognitive Function in Stroke Patients

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ABSTRACT

Introduction: Cognitive impairment is one of the many stroke effects. White matter damage, microinfarcts, microbleeding, atrophy, and amyloid buildup in the brain due to stroke are all potential causes of this condition. Cognitive impairment studies have yet to provide a definitive explanation for how this condition develops following a stroke. Blood pressure is one of several risk factors for stroke. Meanwhile, few studies have been conducted on the association between blood pressure and cognitive function in stroke patients, and no definitive results have been established. **Objective:** This research was designed to examine and evaluate the difference in the measured cognitive function category between hypertensive and non-hypertensive hospital admission blood pressure stroke patients. **Methods:** This research used a cross-sectional design with a consecutive sampling method on acute stroke patients at Dr. Soetomo General Academic Hospital. The MMSE (Mini Mental State Examination) was carried out to assess the degree of cognitive function. The blood pressure measured is the hospital admission blood pressure. **Results:** There were 40 patients included in this study. A total of 36 patients (90%) were in the hypertension group (blood pressure ≥ 130/80 mmHg), and 4 patients (10%) were in the non-hypertension group (blood pressure < 130/80 mmHg). The MMSE results showed that 10 patients performed with no cognitive impairment, 12 patients performed with mild cognitive impairment, and 18 patients performed with severe cognitive impairment. Statistical analysis of the Mann-Whitney U test showed that $p = 0.561$. **Conclusion:** There was no difference in the measured cognitive function category between hypertensive and non-hypertensive hospital admission blood pressure stroke patients.

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INTRODUCTION

The prevalence of stroke is estimated at 101 million people worldwide, and deaths due to stroke are estimated at 6.55 million people.[1] According to the Ministry of Health's 2018 Basic Health Research, the stroke prevalence in Indonesia was estimated to be 10.9 per mile, with East Java Province having a stroke prevalence of 12.4 per mile.[2] The stroke mortality rate in 2019 is expected to be 37.0 per 100,000 occurrences, a 6.6% decrease over the previous decade.[3]

High blood pressure is a risk factor for strokes. This condition can impair cognitive function by triggering damage to the white matter, microinfarctions, microbleedings, amyloid buildup, and left frontal lobe atrophy of the brain.[4] High blood pressure is also known to cause atrophy of the hippocampus.[5] A study found that high blood pressure works synergistically with crown amyloid beta (Aβ) and tau in the cerebrum.[6]

Lowering mortality rates from stroke is a sign that public health is getting better. This is due to a number of factors, such as fewer cases and deaths, better health services, and better control of risk factors.[7] In Indonesia, primary care doctors have a moderate or sufficient level of awareness about acute stroke, as well as good knowledge of how to respond to it.[8]

Stroke can induce problems other than death, such as neurological complications, infections, immobility difficulties, pain, psychological complications, and others. Cognitive impairment is one manifestation of psychological complications.[9] According to the American Psychiatric Association, there are six domains of cognitive function in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5), namely perceptual-motor function, executive function, attention complex, social cognition, learning and memory, and language.[10] Post-stroke cognitive impairment is a common occurrence in the first year after a stroke, with various degrees of severity and the potential for reversal.[11]

A study in Scotland found that 36% patients in the hospital had problems such as impaired cognitive function. According to this figure, cognitive function decrease is the most common psychological complications, followed by depression, emotions, and anxiety.[9] A cohort study of post-stroke cognitive impairment (PSCI) within 2–6 months after stroke found a frequency value of 44% for decline in general cognitive function and 30–35% for decline in one domain of cognitive function.[12]

Cognitive impairment in stroke is defined as a decrease in function in one or several cognitive domains. The prevalence of decreased functioning varies by domain. Decreased functioning in each domain has a different prevalence.[13] Decreased cognitive function in each domain varies in severity.[14]

Measuring cognitive function can be done with several tests, one of which is the Mini Mental State Examination (MMSE).[15–18] The MMSE is generally used as a screening tool for patients with mild cognitive impairment (MCI).[16] Nevertheless, the MMSE can be used well to diagnose cognitive decline in acute stroke patients.[15]

In stroke patients, hospital admission blood pressure is one of the factors that influence the probability of successful reperfusion and the patient's clinical condition.[19] Blood pressure at hospital admission is also known to be related to the annual medical costs for stroke patients.[20] Given the relationship between hospital admission blood pressure and stroke patient condition, it is not impossible that it could be related to stroke patient cognitive function. However, the association between hospital admission blood pressure and cognitive function in stroke patients has not yet been widely discussed.

OBJECTIVE

The objective of this study was to find out if there was a difference in the category of cognitive function measured on the MMSE (Mini-Mental State Examination) between hypertensive and non-hypertensive hospital admission blood pressure stroke patients. Clinically, it could be a consideration to determine the potential value of hospital admission blood pressure as a predictor of cognitive function in stroke patients after the acute phase.

METHODS

This study used a cross-sectional design with a consecutive sampling method to include patients who had an acute stroke in the Seruni A neurological ward at Dr. Soetomo General Academic Hospital, Surabaya, between February and July 2023 and met the inclusion and exclusion criteria. The inclusion criteria were patients diagnosed with stroke, having hospital admission blood pressure data, being willing to take part in the study, and being aged 18 years or more. Exclusion criteria were stroke patients with decreased consciousness, aphasia, and sepsis.

Patients diagnosed with stroke exhibit rapid onset of neurological deficits lasting for over 24 hours and/or have the potential to cause death due to vascular factors, without any other clear cause.[21] Hospital admission blood pressure data is the systolic and diastolic blood pressure values measured in mmHg units when the patient was first admitted to the

hospital for a stroke. Indicating the patient's willingness in the informed consent form serves as proof of the patient's willingness to participate in the research. The patient's identity card's birth date serves as evidence of the patient's age. Stroke patients are classified as having decreased consciousness if their Glasgow Coma Scale score is less than 15 (4-5-6), in order to exclude patients who are unable to complete the MMSE from calculation. Patients are categorized as having aphasia if they experience language problems due to damage to the brain. Patients are diagnosed with sepsis if they meet the Quick Sequential Organ Failure Assessment (qSOFA) criteria.

Assessment of the cognitive function degree with the MMSE was carried out after the acute phase of stroke. The MMSE assessment is carried out in the range of 1–18 days after the onset of stroke. Cognitive function is divided into 3 categories: no cognitive impairment (MMSE 24–30), mild cognitive impairment (MMSE 18–23), and severe cognitive impairment (MMSE <18).[22] Hospital admission blood pressure is divided into 2 categories: non-hypertensive and hypertensive (SBP ≥ 130 mmHg and/or DBP ≥ 80 mmHg).[23]

The analysis of research variable data was carried out using IBM SPSS Statistics 25. The nominal-ordinal data comparative analysis process was carried out using the Mann-Whitney U test.[24]

RESULTS

The study included a total of 40 patients who met the inclusion criteria and didn't meet the exclusion criteria. There were 20 men (50%) and 20 women (50%) with an average age of 58.38 ± 1.29 years. Each patient was or had been married. There were 25 patients with job status (62.5%) and 15 patients without a job (37.5%). Based on the highest level of formal education ever achieved, 4 patients (10%) had no formal education, 19 patients (47.5%) completed elementary school, 7 patients (17.5%) completed junior high school, 7 patients (17.5%) completed senior high school, and 3 patients (7.5%) completed a bachelor's degree (Table 1).

Table 1. Demographic and clinical information

Variable		Score	Range
Age	Both	58.38 ± 1.29	37–75
	Female	60.65 ± 1.52	47–75
	Male	56.20 ± 1.98	37–72
Sex	Female	20 (50%)	-
	Male	20 (50%)	-
Marriage Status	Married	40 (100%)	-
	Single	0	-
Occupation	Employed	25 (62.5%)	-
	Unemployed	15 (37.5%)	-
Educational History	No formal education	4 (10%)	-
	Elementary School	19 (47.5%)	-
	Junior High School	7 (17.5%)	-
	Senior High School	7 (17.5%)	-
	Bachelor Degree	3 (7.5%)	-
Systole		150.95 ± 3.27	113–189
Diastole		89.28 ± 2.68	56–161
Blood Pressure	Non-hypertension		
	- Normal	3 (7.5%)	-
	- Elevated	1 (2.5%)	-
	Hypertension		
	- Stage 1	4 (10%)	-
	- Stage 2	32 (80%)	-
MMSE		19.27 ± 0.68	5–30
Cognitive Function	No cognitive impairment	10 (25%)	-
	Mild cognitive impairment	12 (30%)	-
	Severe cognitive impairment	18 (45%)	-

The average systolic blood pressure was 150.95 ± 3.27 mmHg, with a diastolic pressure of 89.28 ± 2.68 mmHg. The blood pressure status of 36 patients (90%) was hypertensive and 4 patients (10%) were not hypertensive. Normal blood pressure was reported by 3 patients (7.5%), elevated 1 patient (2.5%), hypertension stage 1 by 4 patients (10%), and hypertension stage 2 by 32 patients (80%). The average MMSE score was 19.27 ± 0.98, with details of 10 patients (25%) with no cognitive

impairment, 12 patients (30%) with mild cognitive impairment, and 18 patients (45%) with severe cognitive impairment.

Data analysis of blood pressure in the form of hypertension or non-hypertension with cognitive function in the form of no cognitive impairment, mild cognitive impairment, or severe cognitive impairment using the Mann-Whitney test revealed no significant difference in cognitive function between hypertensive and non-hypertensive subjects (p = 0.561) (Table 2).

Table 2. Mann-Whitney test between hypertension and non-hypertension with cognitive function

	Cognitive Function						p-value
	No Cognitive Impairment		Mild Cognitive Impairment		Severe Cognitive Impairment		
	N	%	n	%	n	%	
Hypertension	1	2.5	10	25	17	42.5	0.561
Non-hypertension	9	22.5	2	5	1	2.5	
Total	10	25	12	30	18	45	
Mann-Whitney test; Hypertension mean rank 17.50; non-hypertension mean rank 20.83							

DISCUSSION

According to the findings of this study, the mean age of the patients was 58.38 ± 1.29 years. Male patients had a mean age of 56.10 ± 1.98 years, while females had a mean age of 60.65 ± 1.52 years. These results align with previous studies, which have shown that strokes occur at a younger age in males and at an older age in females.[25,26]

This study includes 20 male patients (50%) and 20 female patients (50%). Gender-related trends in stroke occurrence are still being debated in the existing literature.[26,27] Some studies suggest a higher incidence of strokes in women, while others report a greater tendency for strokes in men.[28,29]

The mean systolic blood pressure in this study was 150.95 ± 3.27 mmHg. Elevated or decreased systolic blood pressure values in ischemic stroke patients may indicate the potential for unfavourable outcomes, as shown by the U or J graphs.[30,31,32] In contrast to ischemic stroke, no association was found between systolic pressure and the clinical status of patients with hemorrhagic stroke.[30] Other studies have suggested that maintaining systolic blood pressure below 140 mmHg in hemorrhagic stroke can lead to more favourable outcomes.[33,34]

In this study, the mean diastolic blood pressure was 89.28 ± 2.68 mmHg. It is important to note that low diastolic blood pressure (less than 70 mmHg) has been associated to a higher occurrence of heart disease and less favourable stroke outcomes, as assessed by the NIHSS.[20] Other studies, however, have found that diastolic blood pressure more than 80 mmHg is associated with poor outcomes in cases of ischemic stroke.[35,36]

The majority of the study subjects (n = 32, n% = 80%) had systolic blood pressure > 140 mmHg or diastolic blood pressure > 90 mmHg when they arrived at the hospital. With these values, blood pressure can be categorized as stage 2 hypertension.[23] High blood pressure, especially above 115/75 mmHg, increases the risk of stroke.[37] Other studies mention that those aged ≥ 65 years have a higher risk of stroke if their blood pressure is ≥ 160/90 mmHg and ≥ 130/80 mmHg for those under 65 years old.[38]

In addition to its association with the occurrence of stroke, several studies endeavours have sought to establish a connection between blood pressure and the prognosis of stroke patients. Reduced blood pressure within the initial 24 hours following acute ischemic stroke has been found to correlate with more favourable outcomes, as measured through disability measurements using the Rankin Scale.[39] In contrast, in cases of hemorrhagic stroke, achieving lower blood pressure by implementing blood pressure-lowering therapy has been associated to improved disability outcomes as evaluated by the Rankin Scale.[40]

Aside from disability, cognitive function is also a concern in stroke cases. Cognitive function is divided into several domains. These cognitive domains serve as the criteria for diagnosing various cognitive function disorders. According to the study, there are four domains: memory, attention, language, and orientation.[41] However, the American Psychiatrist Association's DSM-5 defines six domains of cognitive function: complex attention, executive function, learning and memory, language, motor perception, and social cognition.[42]

The association between blood pressure and cognitive function in stroke patients is still debated.[43] In this study, there was no significant difference in cognitive function among stroke patients based on their hospital blood pressure status, whether they were hypertensive or not (U = 93, p > 0.05). These findings are consistent with previous studies showing that blood pressure levels, particularly systolic blood pressure, do not associate with cognitive performance in stroke survivors.[44] There is no clear evidence that hypertension lowers cognitive function in middle-aged subjects.[45] Another study also found no differences in

cognitive function between older adults with and without self-reported hypertension.[46]

Several factors can make the difference between high and low blood pressure on cognitive function insignificant. The location and severity of the stroke are two factors that can influence cognitive function in post-stroke patients.[47] Apart from that, nutritional supplementation influences stroke patient recovery, including cognitive function.[48]

Age and gender are known to influence the relationship between blood pressure and cognitive function. Higher systolic and diastolic blood pressure was associated to lower cognitive function in men 45 to 55 years old, but not as strongly as it was in men 65 to 74 years old. The same study also found that systolic and diastolic blood pressure were not associated with cognitive function in women aged 45 to 55. However, higher systolic blood pressure was associated to lower cognitive function in women aged 65 to 74.[49]

Hormones have a significant impact on cognitive function. Exogenous sex hormones have been shown to improve certain cognitive abilities and may be used as cognitive enhancers. Exogenous estrogen can improve verbal abilities, while exogenous androgen enhances mathematical, visual and spatial abilities.[50]

There are some significant concerns for future studies into the correlation between blood pressure and cognitive function in stroke patients. During the conduct of comparative statistical tests in this study, subjects were not specifically differentiated or divided into age categories or educational backgrounds. However, the MMSE's assessment of the relationship between blood pressure and cognitive function in older people did not show a significant relation.[51] Other studies have found that the length of education can have a positive impact on cognitive function and vice versa, indicating a reciprocal relationship between the two.[52] Furthermore, there is a need for cognitive function assessment tools that offer heightened sensitivity and specificity, especially for stroke patients, as well as the ability to account for educational background and age when determining cognitive function outcomes. The MMSE has shown lower sensitivity and specificity compared to memory and executive screening (MES) in detecting subtle cognitive decline.[53]

CONCLUSION

There was no difference in the measured cognitive function category on the MMSE (Mini-Mental State Examination) between hypertensive and non-hypertensive hospital admission blood pressure stroke patients. In this research, cognitive function via MMSE scores in stroke patients could not be predicted via hospital admission blood pressure.

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Conflict of Interest
The authors have no conflict of interests.

Ethic Consideration
This research has been declared in accordance with the Office for Human Research (OHRP) by the Health Research Ethics Committee of Dr. Soetomo General Academic Hospital in Letter of Exemption No. 1178/LOE/301.4.2/XII/2022. Participants who are willing to take part in this research have expressed their willingness by agreeing to the informed consent and information provided.

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Author Contribution
The first author conceived and designed the analysis, collected the data, performed the data analysis, and wrote the paper. The second and third authors helped organize, design the analysis, and revise the paper.

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