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# CORRELATION OF SODIUM, POTASSIUM, AND CALCIUM SERUM LEVELS AND MOTOR FUNCTION OUTCOME WITH ISCHEMIC STROKE PATIENTS IN HAJI ADAM MALIK GENERAL HOSPITAL, MEDAN

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## Abstract
**Background:** Ischemic stroke is the second caused of death at the age of more than 60 years and is a major cause of disability in adults. Disability is caused by motor disorders, nearly 80% of ischemic stroke patients experience motor disturbances. Stroke patients are also often found electrolyte disturbances that affect the clinical outcome of ischemic stroke patients.
**Objective:** To determine correlation of sodium, potassium, and calcium serum levels on admission with motor function outcome of ischemic stroke patients.
**Research Methods:** This study was a cross-sectional study selected with consecutive sampling techniques, where patients diagnosed with ischemic stroke treated at Haji Adam Malik General Hospital Medan who met the exclusion and inclusion criteria were included in this study. The study began from March to June 2020.
**Results:** This study was conducted on 33 samples consisting of 18 men and 15 women with an average age of $59.85 \pm 10.91$ years. There was no significant relationship between serum sodium levels at admission with MAS scores (p= 0.945) with very weak correlation strength (r= 0.013). There was no significant relationship between serum potassium levels at admission with MAS score (p= 0.225) and weak correlation strength (r= 0.217). There was a significant relationship between serum calcium levels at admission with MAS scores (p= 0.001) with moderate correlation strength (r= 0.536)
**Conclusion:** There is no correlatiaon between serum sodium and potassium levels with motor function outcome.There is a correlatiaon between serum calcium levels and motor function outcome.

## Introduction
Stroke is a clinical manifestation in the form of focal and global neurological deficits that occur suddenly in a period of more than 24 hours or that cause death which causes vascular abnormalities in the head[1]. Stroke occurs due to disruption of blood vessels in the brain that is due to a blockage of the blood vessels of the brain or rupture of blood vessels of the brain[2].

Stroke is a major cause of disability in adults[3]. Disability due to stroke is caused by motor disorders. Motor disturbances occur in 80% of patients who experience a stroke, disruption in the form of loss or reduced control of muscle strength or limitations in movement[4]. The Motorcycle Assessment Scale (MAS) score is one device that can be used to assess motor outcomes in stroke patients. The Motor Assessment Scale has good reliability and validity and is a simple, fast and efficient tool for assessing motor outcomes in stroke patients[5].

In addition to experiencing motor disorders, stroke patients treated in hospitals often experience electrolyte disturbances. Research conducted by Kembuan and Sekeon in 2014 showed that acute stroke patients had electrolyte disturbances, with a percentage of 45.9%. Electrolytes that are often disrupted in stroke are sodium, potassium, and calcium[6]. Patients with electrolyte disturbances have higher mortality compared to patients without electrolyte disturbances[7]. Electrolyte disturbances in ischemic stroke patients can be caused by neuron changes at the cellular level that is due to the hypoxia it causes[8].

Electrolytes play an important role in muscle contraction, electrolytes referred to in this study include sodium, potassium, and calcium[9]. Therefore, researchers want to assess the relationship between serum sodium, potassium,

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and calcium levels with motor output of patients with ischemic stroke so that in the future knowing serum sodium, potassium and calcium levels can be predicted how motor outcomes in ischemic stroke patients.

## Method

### Research sample
The study sample was taken from patients with ischemic stroke who came to H. Adam Malik General Hospital Medan using consecutive sampling techniques. Research subjects were 33 ischemic stroke patients.

### Study design
This research is analytic descriptive with cross sectional data collection method with the source data obtained is primary data from all ischemic stroke sufferers who are hospitalized in the Department of Neurology FK-USU/ H. Adam Malik Hospital Medan.

### Statistic analysis
Data from the study were statistically analyzed using the SPSS computer program version 22.0. To determine correlation of sodium, potassium, and calcium serum levels on admission with motor function outcome of ischemic stroke patients

## Results
Case study subjects consisted of patients diagnosed with ischemic stroke at H. Adam Malik General Hospital Medan  in March 2020 until June 2020, as many as 33 subjects who met the research criteria. Age characteristics of all study subjects had a rate value of around 59,85±10,91 years with the most age range in ischemic stroke subjects at age 56-<72 years as many as 19 subjects (57.6%). Ischemic stroke were mostly male, with 18 subjects (54.5%). The highest level of education ischemic stroke subjects is SMA, with 14 subjects (42.4%). The occupational status ischemic stroke subjects were mostly enterpreneur, namely 11 subjects (33.3%). Most of ischemic stroke patient tribes were Batak tribes, namely 14 subjects (42.4%). For complete data on the characteristics of the subjects of this study are presented in table 1 below.

*Table 1. Overview of Characteristics of Research Subjects*

| Characteristics of Research Subjects | Average | N(33) | % |
|---|---|---|---|
| Age (years) | 59,85±10,912 | | |
| -  41<56 years | | 11 | 33,3 |
| -  56<72 years | | 19 | 57,6 |
| -  72<88 years | | 3 | 9,1 |
| Gender | | | |
| -  Male | | 18 | 54,5 |
| -  Female | | 15 | 45,5 |
| Etnics | | | |
| -  Batak | | 14 | 42,4 |
| -  Karo | | 10 | 30,3 |
| -  Jawa | | 7 | 21,2 |
| -  Aceh | | 2 | 6,1 |

The patient's serum sodium level is classified as normonatremia if the serum sodium level is 135-145 mEq / L, hyponatremia if the serum sodium level is less than 135 mEq / L, and hypernatremia if the sodium is more than 145 mEq / L. There were 28 (84.8%) patients with normonatremia, 5 (15.2%) hyponatremia patients, and 0 patients who were hypernatremia. The median value of MAS scores of normonatremia patients is greater than that of hyponatremia. However, through the Mann-Whitney test there was no significant difference between the MAS scores of patients with normonatremia and hypontremia (p = 0.119).

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The patient's serum potassium levels are classified as normocalemia if the potassium level is 3.5-5.3 mEq / L, hypokalemia if the potassium level is less than 3.5 mEq / L and hyperkalemia if the potassium level is more than 5.3 mEq / L. There were 27 (81.8%) patients with normokalemia, 6 (18.2%) hypokalemia patients, and 0 patients with hyperkalemia. The median value of normokalemia is higher than hypokalemia. However, through the Mann-Whitney test there was no significant difference between the MAS scores with normokalemia and hypokalemia ($p = 0.426$).

The patient's serum calcium levels are classified as normocalcemia if calcium levels are 8.6-10.3 mg / dl, hypocalcemia if calcium levels are less than 8.6 mg / dl and hypercalcemia if calcium levels are more than 10.3 mg / dl. There were 17 (51.5%) normocalcemia patients, 9 (27.3%) hypocalcemia patients, and 7 (21.2%) hypercalcemia patients. There is a significant difference in MAS scores between serum levels of normocalcemia, hypocalcemia, and hypercalcemia ($p = 0.012$) examed by Kruskal-Wallis test. For complete data on the characteristics of serum sodium, potassium, and calcium with MAS scores of this study are presented in table 2 below.

*Table 2 Characteristics of sodium, potassium and calcium serum level with MAS scores*

|  | n(%) | MAS Score | Nilai p |
|---|---|---|---|
| Sodium Serum Level | | | 0,119* |
| Normonatremia | 28(84,8) | 19(4-48) | |
| Hiponatremia | 5 (15,2) | 13(7-27) | |
| Potassium Serum Level | | | 0,426* |
| Normokalemia | 27(81,8) | 21(4-48) | |
| Hipokalemia | 6(18,2) | 13(7-48) | |
| Calcium Serum Level | | | 0,012** |
| Normokalsemia | 17(51,5) | 15(5-42) | |
| Hipokalsemia | 9(27,3) | 8(4-48) | |
| Hiperkalsemia | 7(21,2) | 38(17-48) | |

The table 3 show the relationship of sodium serum levels at admission with MAS scores was tested with the Spearman test. There was no significant relationship between serum sodium levels at admission with MAS scores of ischemic stroke patients with p value 0.945 with negative correlation direction and very weak correlation strength ($r = 0.013$).

*Table 3 Relationship between sodium serum levels at admission to ischemic stroke patients with motor outcome*

|  | MAS Score |
|---|---|
| Sodium Serum Level | r=0,013<br>p<0,945<br>n=33 |

The table 4 show the relationship of potassium serum levels at entry with MAS scores was tested with the Spearman test. There was no significant relationship between serum potassium levels at admission with the MAS score of ischemic stroke patients with p value 0.225 with a negative correlation direction and a weak correlation strength ($r = 0.217$).

*Table 4 Relationship between potassium serum levels at admission to ischemic stroke patients with motor outcome*

|  | MAS Score |
|---|---|
| Potassium Serum Level | r=0,217<br>p<0,225<br>n=33 |

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The table 5 show the relationship of calcium serum levels at admission with MAS scores was tested with the Spearman test. Obtained a significant relationship between serum calcium levels at admission with MAS scores of ischemic stroke patients with p value 0.001 with a positive correlation direction and moderate correlation strength  (r = 0.563).

*Table 5 Relationship between calcium serum levels at admission to ischemic stroke patients with motor outcome*

|  | MAS Score |
| --- | --- |
| Calcium Serum Level | r=0,563 |
|  | p<0,001 |
|  | n=33 |

## Discussion

In this study, it was found that the most age range was at age 56-<72 years as many as 19 subjects (57.6%). This study was relevant to the research of Aksoy et al (2014) which suggests that age in acute ischemic stroke (66.8 ± 12.8 years) is higher than acute hemorrhagic stroke (61.35 ± 13.7 years). Age is one of the variables that plays an important role in influencing disease. The increase in the frequency of strokes with increasing age is related to the aging process, where all organs of the body experience deterioration of function including the blood vessels of the brain. The blood vessels become inelastic, especially the endothelial area which thickens the intima, resulting in narrowed lumen of the blood vessels and an impact on decreased cerebral blood flow[10].  Male subjects was higher than females with 18 males (54.5%) and 15 females (45.5%). The results of the study are relevant with Sembiring's research (2017) mentioning 31 male subjects (51.7%) are greater than 29 female subjects (48.3%). The positive effects of estrogens on brain circulation. Lifelong estrogen exposure can protect against ischemic stroke, at least from the non-cardioembolic type, where this effect stops with menopause[12].

In this study the Batak tribe is the most ethnic group of the subjects, namely 14 subjects (42.4%). This is relevant to the research of Rambe et al (2013) in the ischemic stroke group as many as 40.7% of the Batak tribe. Batak tribe has more eating characteristics than other tribes so it is more likely to be obese[14]. Typical Batak food also contains a lot of cholesterol levels[15]. This is not relevant to research Riyadina and Rahajeng (2013) which states that the most ethnic groups who suffer a stroke are Sundanese, where research is carried out in West Java. The location of the study affected the type of ethnicity most subjects had a stroke. Most tribes in North Sumatra are Batak tribes, most tribes in West Java are Sundanese[17].

The highest serum sodium levels were found in normonatremia by 28 (84.8%) compared with hyponatremia by 5 subjects (15.2%). In this study subjects with less hyponatremia and no hypernatremia were found because the study subjects used were patients who did not experience decreased consciousness. This is not relevant to Kembuan's research (2015) which states that the most electrolyte disturbance in stroke is hyponatremia. In this study, there was no significant difference between MAS scores in normonatremia and hyponatremia (p = 0.199). This is relevant to the study of Parakkasi et al (2016). There were no significant differences between the MAS scores of patients with hyponatremia, normonatremia, and hypernatremia (p = 0.073).

In this study, the most potassium levels were found in normokalaemia in 27 subjects (81.8%) compared to hypokalaemia in 6 subjects (18.2%). There was no significant difference between MAS scores in normokalemia and hypokalemia (p = 0.426). This is relevant to the research of Haryani et al (2017) which states that there is no significant difference between the MAS scores of hypokalemia and hyperkalemia patients compared with normokalemia (p = 0.962). At the calcium level, the highest calcium levels were found in 17 subjects (51.5%), hypocalcemia as many as 9 subjects (27.3%), and at least in hypercalcemia in 7 subjects (21.2%). The lowest median MAS score was found in hypocalcemia, which is 8. This indicates motor output is worse in hypocalcemia compared with normocalcemia and hypercalcemia. This is relevant to Borah (2016) research on hypocalcemia with a wider area of infarction with worse outcomes. The highest median MAS score was found in hypercalcemia at 38. This is relevant to the study of Gupta et al (2015) ischemic stroke patients who have higher calcium levels have better functional outcomes compared to patients who have lower caslium levels (p <0.001 ).

In this study,  there was no nsignificant relationship was found between serum sodium levels at admission and motor outcomes assessed by MAS scores with p = 0.945 with a negative correlation direction and a very weak correlation strength of r = 0.013. The negative correlation direction means that the higher the serum sodium level

of ischemic stroke patients, the lower the MAS score. This is relevant to the study of Parakkasi et al (2016) who found no correlation between serum sodium levels at admission with MAS scores (p = 0.938). This is also relevant to the research of Kembuan and Sekeon (2014) which states there is no relationship between electrolyte disturbance and the outcome of ischemic stroke patients. In the study of Kembuan et al (2015) there were no significant differences between the mean sodium levels based on the severity of neurological deficits. However, this study is not relevant to the study of Fofi et al (2012) which states that ischemic stroke sufferers who experience hyponatremia and hypernatremia have worse clinical outcomes. This difference in results can occur due to the fact that in this study hyponatremia was only 15.2% and patients with hypernatremia were not found. The number of samples between normonatremia, hyponatremia and hypernatremia that can disproportionately affect the results of this study. Hyponatremia in ischemic stroke can occur due to excessive expression of natriuretic peptides that cause Syndrome of inappropriate secretion of antidiuretic hormone (SIADH) and Cerebral salt wasting syndrome (CSWS).

There was no significant relationship between serum potassium levels at entry with p = 0.225 with a negative correlation direction and a weak correlation with r = 0.217. The direction of the negative correlation means that the higher the serum potassium levels of ischemic stroke patients, the lower the MAS score. This is relevant to the study of Haryani et al (2017) which shows the results of research in the form of a negative relationship is very weak, or is considered to be no relationship between serum sodium levels at admission with MAS scores of ischemic stroke patients. This study is not relevant to research conducted by Moussavi et al (2013) which states that lower potassium levels are associated with worse stroke outcomes. In his study, 543 subjects who were assessed serum potassium levels at entry and compared with NIHSS and mRS scores at discharge, found significant results where low potassium levels below normal at entry had worse NIHSS and mRS scores. In this study a sample of 33 people, 16 times smaller than the study, besides the proportion between normokalemi patients and hypokalemia is not proportional which is likely to affect the results of statistical tests. Kalyan (2017) also mentions that sodium and potassium concentration disorders are electrolyte abnormalities that are often found in cerebrovascular damage and can cause death unless corrected immediately. In an ischemic condition a N-K-ATPase pump failure will occur which causes the release of potassium from inside the cell, so that potassium is higher outside the cell, but this will be compensated by astrocytes through NKCC1 activation. In astrocytes, NKCC1 plays an important role in potassium uptake during high potassium ion conditions[24].

In this study found a significant relationship between serum calcium levels on entry with a MAS score with p = 0.001 with the direction of a positive correlation and the strength of the correlation r = 0.563. The direction of a positive correlation means that the higher the serum calcium level of ischemic stroke patients, the higher the MAS score. This is relevant to the research of Gupta et al (2015) ischemic stroke patients who have higher calcium levels have better functional outcomes compared to patients who have lower calcium levels (p <0.001). Calcium plays an important role in the process of cerebral ischemic pathomechanism. If there is a decrease in blood flow in the brain below 10-12ml / 100 gr / minute there will be an infarction. If the blood flow to the brain decreases to 6-8ml / 100gr / min, there will be a disruption in the ATP pump that causes an increase in extracellular potassium, intracellular calcium, and cellular acidosis which results in histological cell necrosis. Calcium translocation from extracellular to intracellular is mediated by the release of glutamate by ischemic neurons and glia cells, glutamate activates NMDA receptors and triggers this translocation. Transfer of calcium from serum to brain cells through the choroid plexus, this causes a decrease in serum calcium levels[25].

## Conclusion
There is no correlatiaon between serum sodium and potassium levels with motor function outcome. There is a correlatiaon between serum calcium levels and motor function outcome.

## Suggestion
Consideration should be given to examining serum calcium in ischemic stroke patients in assessing motor outcome.

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