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ANALYSIS OF SIRS (SYSTEMIC INFLAMMATORY RESPONSE SYNDROME) COMPONENTS AS PREDICTORS OF OUTCOME OF HEAD INJURY PATIENTS

Novi Mustahdiati Nasri*[1], Titin Andri Wihastuti[2] and Heri Kristianto[3]

[1]Master of Nursing Student, Faculty of Medicine, Brawijaya University, Indonesia.
[2,3]Department of Nursing, Faculty of Medicine, Brawijaya University, Indonesia.

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Corresponding author: Novi Mustahdiati Nasri
Master of Nursing Student, Faculty of Medicine, Brawijaya University, Indonesia.

ABSTRACT

The incidence of head injury in the emergency room at Ulin General Hospital Banjarmasin reached 107 cases per month with the severe head injury patients who died reached 52%. This mechanism of death is associated with inflammatory process known as SIRS (Systemic Inflammatory Response Syndrome). It's important to know the outcome of head injury patients through the SIRS mechanism, one of which uses the GAP score. In addition to supporting clinical decision making and planning necessary actions, it can also help prioritize relief measures for patients who have a greater risk of death. The purpose was to determine whether the components of SIRS could predict the outcome of head injury patients based on the GAP score. This research used observational analytic design and cross sectional approach. Samples were taken using purposive sampling technique, totaling 80 samples. The results showed that pulse rate didn't have a correlation with patient outcome (p value=0.334). The p value for the variable body temperature, respiratory frequency, and leukocyte count were 0.000, 0.003, and 0.042, there is a. After multivariate testing, it was found that SIRS components that can be used as a predictor is body temperature and leukocyte count. Therefore, it can be concluded that two of the four components of SIRS can be used as outcome predictors of head injury patients. Further specific research is needed, especially in severe head injury, so that the resulting predictor is more accurate.

KEYWORDS: Head injury, Systemic Inflammatory Response Syndrome, outcome of head injury patients, GAP score.

INTRODUCTION

Head injury is the most common injury among other injuries. Head injuries that afflict people in productive age are mostly due to traffic accidents and work accidents.[1,2] This is related to the lack of preventive measures and poor security facilities.[3] The consequences are very diverse. Cases of moderate to severe head injury that cause traumatic brain injury are closely related to the economic implications caused, morbidity or disability, and the risk of death of the patient.[4]

A preliminary study conducted at the emergency department of the Ulin Regional General Hospital Banjarmasin showed that there were 1070 cases of head injury over a period of 10 months (January to October 2017), with the incidence of minor, moderate and severe head injuries, respectively 798, 150 and 122 cases. It is mean that there are an average of 80 cases of mild head injury per month, 15 cases of moderate head injury per month, and 12 cases of severe head injury per month. The mortality rate for severe head injury patients during the 10 months reached 63 cases or as much as 52%.

The incidence of death in head injury patients is related to the mechanism of traumatic brain injury, especially through the inflammatory process. Leukocyte activation, vasogenic edema, and blood brain barrier failure happen, that cause brain edema, and then trigger an increase in intracranial pressure, resulting in death.[5,6] During this inflammatory process, various responses that can be observed in patients will appear, and known as SIRS (Systemic Inflammatory Response Syndrome). Its components include body temperature, pulse frequency, respiratory frequency, and leukocyte count.[7,8]

The emergence of SIRS is certainly not a good sign for patients. Therefore, nurses need to detect the risk of death that might occur through this mechanism. The aim is to assist in making appropriate clinical decisions, planning actions needed by patients, and helping prioritize relief measures for patients who have a greater risk of death.[9]

One of scoring system that can be used to assess the outcome of head injury patients is the GAP score. Assessment was carried out on the level of patient awareness measured using the Glasgow Coma Scale (GCS), age, and systolic blood pressure.[10,11,12] Previous research states that GAP score is a good predictor for predicting the death of head injury patients, even more accurate than RTS. The probability level reaches 97.6% to predict the death of head injury patients.[13,14] Therefore, researcher feel interested in researching more about it. Researcher conducted research with the aim to prove that the SIRS component (systematic inflammatory response syndrome) can predict the outcome of head injury patients based on the GAP score.

METHOD

This research used observational analytic research and cross sectional approach. The research was held at IGD Ulin Banjarmasin Hospital for 1 month 10 days, starting from April 20, 2018 until May 30, 2018. The population in this study were all head injury patients who were taken to the Ulin Hospital in Banjarmasin. The sample size in this study were 80 samples that met the criteria: (1) Patients with a single diagnosis of head injury, (2) Patients who received complete blood laboratory examination procedures, (3) Patients aged over 12 years. Samples were taken using purposive sampling technique.

Data collection tools in this study are observation sheets which are divided into 4 parts. The first part contains information about the time of data collection and information related to the patient's identity. The second part is the part whose contents are related to the independent variables. The third part is the part whose contents are related to the dependent variable, namely the data from the GAP score calculated in head injury patients. While the fourth part is the responsibility section of the researcher as the person who filled out the questionnaire, containing the column for the signatures and names of the data takers.

Research respondents, especially in the field of health that involve humans as research subjects, need protection rights with regard to ethical aspects.[15] Patients have autonomy in making their own choices and must be respected. Therefore, the researcher prepared an informed consent form along with a research explanation sheet submitted to the patient before the data collection process. The procedure carried out in this study is a standard procedure that has been carried out on every patient who comes to the Ulin Banjarmasin Hospital General Hospital so that it does not harm the patient. All respondents were given the same treatment in accordance with the research procedure.

The results of data analysis on normally distributed variables are shown in the form of mean and standard deviation. While the variables that are not normally distributed are displayed in the form of median, minimum value, and maximum value. The bivariate test used in this study was the Pearson test on variables that were normally distributed, and the Spearman test on variables that were not normally distributed. The test was continued by multivariate using linear regression. The results obtained in the form of an equation that will be tested for discrimination and calibration.

RESULTS AND DISCUSSION

Table 1: Sample Characteristics Based on GAP Score, Body Temperature, Pulse Rate, Respiratory Frequency, and Leukocyte Count Value.

Parameters	Mean (Standard deviation)	Median (Minimum-Maksimum)
GAP Score	-	1.2788 (0.90-1.38)
Body temperature	-	1.5775 (1.55-1.59)
Pulse Rate	-	1.9912 (1.73-2.21)
Respiratory Frequency	-	1.3617 (1.04-1.62)
Leukocyte Count	1.1659 (0.8769)	-

The results of the normality test showed that the GAP score, body temperature, pulse rate, and respiratory frequency variables showed abnormal results with p values in the Kolmogorov-Smirnov test, respectively 0,000; 0.001; 0.007; and 0.002 (data is stated normal if $p > 0.05$). Therefore, the characteristics of the four variables are displayed using the median and minimum-maximum values as shown in Table 1. Leukocyte count values are presented in the mean and standard deviation because the data are normally distributed with a value of $p = 0.097$.

Table 2: Distribution of Sample Characteristics Based on GAP Score.

Parameters		n (%)
GCS	3	3 (3.75)
	4	3 (3.75)
	5	7 (8.75)
	6	8 (10.00)
	7	5 (6.25)
	8	0 (0.00)
	9	3 (3.75)
	10	2 (2.50)
	11	5 (6.25)
	12	5 (6.25)
	13	2 (2.50)
	14	13 (16.25)
	15	24 (30.00)
Age	< 60 years	63 (78.75)
	> 60 years	17 (21.25)
Systolic Blood Pressure	< 60 mmHg	0 (0.00)
	60-120 mmHg	53 (66.25)
	>120 mmHg	27 (33.75)
Score	Low risk of mortality	43 (53.75)
	Moderate risk of mortality	32 (40)
	High risk of mortality	5 (6.25)

Based on the first GAP Score component, GCS score, the distribution of patients with severe head injury showed that the highest GCS was 6, 8 (10%) of the total sample. The least number is the GCS 3 and 4, which are 3 (3.75%). Patients with moderate head injury were the highest with GCS 11 and 12, respectively 5 (6.25%), and at least GCS 10 and 13, respectively 2 (2.50%). As for mild head injury, 24 (30%) samples had GCS 15 values and the rest had GCS 14 values. Judging from the second GAP Score component, there were 63 (78.75%) samples aged <60 years, and the rest were more than 60 years old. Based on the third component of GAP Score, the most samples had diastolic pressure between 60-120 mmHg, which was 53 (66.25%). Data shows that there are no samples that have diastolic pressure of less than 60 mmHg.

Overall, patients with a GAP score between 19-24 (low mortality risk) were 43 (53.75%). The number of patients with a GAP score between 11-18 (moderate mortality risk) and patients with a GAP score between 3-10 (high mortality risk) were 32 (40%) and 5 (6.25%) samples respectively. Most patients who have a low mortality risk are patients with mild cases of head injury, whereas patients who have a high mortality risk are all patients with severe head injury cases.

Table 3: Distribution of Sample Characteristics Based on Systemic Inflammatory Response Syndrome Components.

Parameters		n (%)
Body temperature	< 36^0C	7 (8.75)
	36-38^0C	50 (62.50)
	> 38^0C	23 (28.75)
Pulse Rate	< 90 tpm	19 (23.75)
	> 90 tpm	61 (76.25)
Respiratory Frequency	< 20 tpm	20 (25.00)
	> 20 tpm	60 (75.00)
Leukocyte Count	< 4,000/µL	0 (0.00)
	4,000-12,000/µL	12 (15.00)
	> 12,000/µL	68 (85.00)

The distribution of the characteristics of the sample seen from the first SIRS component, body temperature, showed that most of the patient's body temperature ranged from 36-38^0C, there were 50 (62.50%). The least has a body temperature of less than 36^0C, which is 7 (8.75%). Based on the pulse frequency, the sample with a pulse rate of more than 90 tpm was 61 (76.25%), and the rest <90 x / minute. Judging from the respiratory frequency, there are 60 (75%) samples with a frequency of more than 20 tpm, and the rest <20 tpm. Based on leukocyte count values, the highest yield was more than 12,000/µL, which was 68 (75%) samples, and no sample had a leukocyte count less than 4,000/µL.

Table 4: Results of Correlation Test between GAP Score with Body Temperature, Pulse Rate Frequency, Respiratory Frequency, and Leukocyte Count.

Variables	GAP Score		
	n	r	*p value*
Body temperature	80	-0.513	0.000
Pulse Rate	80	-0.110	0.334
Respiratory Frequency	80	-0.327	0.003
Leukocyte Count	80	-0.527	0.000

Correlation test results show that only the pulse frequency variable that does not have a correlation difference, indicated by p value = 0.334 (expressed differently if p <0.05) so that this variable cannot be continued to the regression test. The p value for the variable body temperature, respiratory frequency, and leukocyte count values were 0.000, 0.003, and 0.042. That is, there is a difference in the correlation between the GAP score and the three variables. Spearman correlation value on body temperature variable is -0.513, which means the direction of negative correlation with strong correlation strength. Respiratory frequency variables and leukocyte count values resulted in correlation values respectively r = -0,327 and -0,228, indicating a negative direction of correlation. The strength of the correlation for the variable respiratory frequency is moderate, and the strength of the correlation for the variable leukocyte count value is strong.

Relationship of Body Temperature with Outcome Patient Head Injuries

Humans have two compartments that regulate body temperature, namely central and peripheral. The central compartment is the perfect center of regulation in all conditions, occurring in the hypothalamus. Heat exchange occurs rapidly in this compartment, and the temperature is relatively homogeneous. Changes in brain temperature significantly affect vascular, metabolic and neuronal parameters.[16]

Peak temperatures below 37^0C and above 39^0C in the first 24 hours after the event are associated with an increased risk of death in patients with stroke and brain injury. Temperature changes of more than 10C significantly changed both functional and histopathological neurological outcomes. Brain oxygen consumption dramatically decreases at 37^0C below. All energy production lines in the brain, including the brain's metabolic rate for glucose and lactate are also reduced. Meanwhile, at brain temperatures above 39^0C there will be an increase in extracellular amino acid levels, opening of the blood brain barrier, and an increase in neuronal cytoskeleton proteolysis.[16]

Cerebral blood flow will change with temperature changes. This change is proportional to changes in cerebral metabolism caused by temperature variations. Because of the physiological coupling between cerebral blood flow and metabolism, a decrease in brain temperature will cause a decrease in intracerebral vascular volume and intracranial pressure.[17] In addition, the level of carbon dioxide (CO_2), or the partial pressure of CO_2 ($PaCO_2$) in arterial blood also depends on temperature. When the temperature decreases, the amount of CO2 decreases.[16]

Correlation of Pulse Rate Frequency with Head Injury Outcome Patients

The data in this study indicate the existence of pulse frequency diversity, even in the same classification of head injuries. In addition to being influenced by the classification of data (using numerical data), this diversity occurs because the response of each patient to the injuries they experience varies. Specifically, it can be stated that the pulse frequency does not describe a specific response to head injury, but is also influenced by other factors.

The pulse frequency is known to be influenced by a variety of factors, including physiological, pathological, neuropsychological, lifestyle, and environmental factors such as workloads.[18,19] Similarly, the etiology of injury is complex, dynamic, multifactorial, and context-dependent.[20] Head injury patients with a level of awareness that is still good, for example in mild head injury patients and some moderate head injury patients, experience an increase in pulse frequency which is not only due to the severity of the condition of the injury, but also influenced by physiological conditions and external factors.

Relationship of Respiratory Frequency with Outcome Patient Head Injuries

Not all increases in respiratory frequency in head injury patients indicate the severity of brain injury. Many other things affect the increase in respiratory frequency. This explains why in this study respiratory frequency cannot be used as an indicator of the poor outcome of head injury patients based on the GAP score. Masaoka (2011) states that there is a correlation between anxiety levels and respiratory rate.[21] This statement is reinforced by research conducted by Giardino (2017) which states that respiratory dysregulation is a characteristic and diagnostic feature of several anxiety disorders. Patients with panic disorder, for example, usually show chronic hyperventilation, respiratory pattern instability, and frequent sighs, even during panic-free periods.[22] Panic attacks originate from a fear network centered in the center of the amygdala nucleus that sends stimulation to the parabrachial nucleus to increase the rate of respiration, and also to the lateral nucleus of the hypothalamus to activate the sympathetic nervous system.[23]

Another factor that can affect the frequency of breathing is pain. As stated by Bendall (2011), in adults, respiratory rate of 25 times / minute or more is the most important predictor that a person has more pain. That is, there is a positive relationship between respiratory frequency and pain. The heavier the pain suffered, the faster the respiratory frequency will be.[24]

Some conditions and diseases also affect the respiratory frequency. The occurrence of airway obstruction triggers a person to breathe quickly and deeply to get as much oxygen as possible. These conditions often occur in patients with asthma and chronic obstructive pulmonary disease.[25,26] Other factors that affect respiratory frequency are chemical changes that occur, for example in hypoxic conditions, metabolic disorders, and drug use. Barbosa (2017) revealed the stimulating effect of insulin to increase respiratory rate in humans.[27]

Relationship of Leukocyte Count Value with Outcome Patient Head Injury

Increased leukocyte count values are caused by posttraumatic leukocytosis. Leukocytosis in trauma triggered by neutrophilia due to neutrophil margins. This phenomenon only lasts a few minutes to 1 post-trauma.[28] Rovlias (2011) prospectively studied 624 patients with head injuries and found patients with severe head injuries had significantly higher levels of leukocyte count than those with moderate or mild injuries. In patients with severe head injury, leukocyte count values are also associated with poor outcomes.[29] This is in line with the results of research conducted by Gurkanlar (2009) which states that high white blood cell counts are associated with greater neurological severity, whereas patients with low white blood cell counts have better outcomes.[30]

Table 5: Results of Multivariate Linear Regression Analysis.

Steps	Variables	Coefficient	correlation coefficient	*P value*
Step 1	Body temperature	-3.208	-0.279	0.006
	Respiratory frequency	-0.150	-0.132	0.170
	Leukocyte count	-0.607	-0.450	0.000
	Constant	7.202		0.000
Step 2	Body temperature	-3.757	-0.327	0.001
	Leukocyte count	-0.590	-0.437	0.000
	Constant	7.841		0.000

Based on the results of multivariate analysis using linear regression showed no missing data. The backward method produces only the variable body temperature and leukocyte count values that can be included in the equation and made the outcome predictors of head injury patients. This is because the p value for the variable respiratory frequency is 0.170 (> 0.001). The equation obtained is as follows:

y = 7,841 - 3,757 (body temperature) - 0,590 (leukocyte count)

The ANOVA for calibration = 0,000. That is, this equation can be used to predict the outcome of head injury patients based on the GAP score. But the discriminatory value is only 0.361. So that this equation can only predict the outcome of head injury patients by only 36.1%, while 63.9% is determined by other factors. The factors that can influence include the following:

Hypotension: Defined as an average arterial pressure of less than 70mmHg. A multicentre study found that blood pressure of less than 80mmHg was one of the factors associated with poor patient outcomes.[31]

Hypothermia: Hypothermia continues to be a controversial area in the management of head injury patients. A study showed that 16% of patients with TBI cooled to 32^0C within 6 hours of injury had good results compared to those maintained at 37^0C.[32]

Electrolyte changes: Ionic homeostasis and impaired neurotransmitters are recognized as the most important mechanisms that contribute to the development of secondary brain swelling. Glutamate may be responsible for increasing prolonged extracellular potassium by opening permeable potassium ion channels operated by agonists. This was demonstrated by using patch clamping techniques that cyclic AMP channels become more permeable to ions, and that this is mediated by prolonged agonists (glutamate) to bind to receptors. It was found that an increase in potassium in 20% of patients with TBI was highly correlated with poor outcomes. Almost certainly this is related to otassium-induced astrocyte swelling.[33]

Multiple injuries: More than 50% of severe TBI patients have life-threatening injuries. The relationship of head injury to chest injury or abdominal injury can certainly worsen the patient's prognosis. Studies show that a combination of head injury with chest injury or abdominal injury results in a worse impact on patients than a combination of head injury with other injuries.[34]

Gender: Gender has an independent predictor for survival. A study showed that women were 1.75 times more likely to die of brain injury than men, and 1.57 times more likely to experience poor outcomes (severe disability or persistent vegetative state) than men.[35]

Neurological Assessment: The Glasgow Coma Scale (GCS) is important in the management of traumatic brain injury, and is the most widely accepted and understood scale (Wardlaw, 2012). GCS is one of the most common tools used by trauma care providers because it allows the gradation of head injury severity to use simple observation rather than invasive techniques. GCS is commonly used to predict patient outcomes after trauma.[36]

CONCLUSION

In general it can be concluded that the SIRS component (systematic inflammatory response syndrome) can predict outcome in head injury patients based on the GAP score through the equation y = 7,841 - 3,757 (body temperature) - 0,590 (leukocyte count). This equation can predict patient outcomes as much as 36.1%. The other 63.9% can be affected by various conditions experienced by patients, including hypotension, hypothermia, changes in electrolytes, multiple injuries (multiple trauma), gender, and neurological conditions of the patient.

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