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Original Research

The Correlation of Hemodynamic Status and Oxygen Saturation with The Level of Consciousness in Head Injury Patients

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Abstract

Introduction: Head injury is a traumatic disorder caused by the mechanical strength of a blunt object or penetration that can cause temporary or permanent changes in tissue function and structure. The latest developing concept on poor prognosis among head injury patients was occur related to the secondary injuries, where there was an increase in intracranial, cerebral ischemia, and decreased consciousness. The important thing in the management of head injuries is to maintain hemodynamic stability and to prevent hypoxia by maintaining oxygen saturation >95%. The purpose of this study was to analyze the correlation of hemodynamic status and oxygen saturation with the level of consciousness in head injury patients at RSUD Mardi Waluyo, Blitar.

Methods: The research used correlational analytical with a cross-sectional design. The sampling technique used consecutive sampling within a total sample of 30 respondents. Spearman's test was used for data analysis.

Results: The results showed a correlation between mean arterial pressure (p-value = .004), respiratory rate (p-value = .000), body temperature (p-value = .017), and oxygen saturation (p-value = .000) with level of consciousness (GCS) respectively.

Conclusion: It can be concluded that mean arterial pressure, respiratory rate, body temperature, and oxygen saturation can affect the level of consciousness (GCS). There was a need to improve hemodynamic and oxygen saturation monitoring to prevent the bad prognosis in head injury patients at RSUD Mardi Waluyo, Blitar.

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INTRODUCTION

Head injury is a traumatic disorder caused by the mechanical strength of a blunt object or penetration that can cause temporary or permanent changes in tissue function and structure [1]. One concept that has evolved lately is that the causes of mortality and morbidity of head injuries were not due to primary injuries, but due to worsening secondary injuries. Therefore, it is important to minimize the risk for secondary injury in the patient which will worsen the prognosis.

In 2014, an average of 155 people in the United States died every day due to head injuries [2]. In European countries, the head injuries account for 75% of total deaths among users of motorcycles and bicycles. In several low and middle-income countries, head injuries are estimated at 88% of total road fatalities [3]. The World Health Organization (WHO) estimates in 2020 traffic accidents become the third largest cause of death and disability in the world [1].

There are various ways of assessing the prognosis of head injuries, most often used the Glasgow Coma Scale (GCS). Glasgow Coma Scale assessment is based on eye, verbal, and motor responses. Patients in a coma, especially head injury patients, will generally give an unstable hemodynamic status, the blood pressure is generally elevated but the breathing and pulse are slows down. The instability of hemodynamic status in head injury patients will affect increasing intracranial pressure [4]. The intracranial pressure increase occurs due to the failure of compensatory brain autoregulation. Increased intracranial pressure can significantly reduce blood flow and cause ischemia. If complete ischemia occurs and lasts more than 3 to 5 minutes, the brain will suffer irreversible damage. The decreased in cerebral perfusion will affect the cell state and results in cerebral hypoxia [5].

The important thing in the management of head injuries is to maintain hemodynamic stability and to prevent hypoxia by maintaining oxygen saturation >95%. Observation of oxygen saturation is the key to prevent and recognize the risk for tissue hypoxia that can cause cell death [6]. Moreover, one of the most important things in nursing care to head injury patients is maintaining adequate cerebral perfusion pressure. Cerebral perfusion depends on the pressure gradient of the arteries of the cerebral arteries. When the intracranial pressure increases, the Cerebral Perfusion Pressure (CPP) will decrease and cause the lower limit of autoregulation runs out, Cerebral Blood Flow (CBF) will start to fall and causing ischemia, which in turn will increase swelling. The vital signs are also affected due to an increase in intracranial pressure [7].

The hypotension will decrease the CBF which leads to cerebral ischemia. Blood pressure is directly related to cerebral blood volume, perfusion pressure, and ischemia. In patients with head injuries maintaining CPP and maintaining systemic oxygenation are two important objectives that are related to Mean Arterial Pressure (MAP) and vital signs [8]. The purpose of this study was to explore the correlation of hemodynamic status and oxygen saturation to the level of consciousness in head injury patients.

METHODS

The design of this study was correlational analytical with cross-sectional. The study was conducted in the RSUD Mardi Waluyo, Blitar City, East Java Province, Indonesia on 05th December 2019 – 05th January 2020. The sampling technique used consecutive sampling recruited 30 respondents.

Researchers screened each of head injury patient who entered the emergency room at RSUD Mardi Waluyo, Blitar City based on inclusion criteria including head injury patients treated at the emergency room, aged ≥ 18 years, agreed to sign the informed consent, had no complications on cardiovascular disease, and had no history of hypovolemic shock. While the exclusion criteria in this study were including patients who refused informed consent, and patients with a history of alcohol and drug users. The analog tensimeter was used to measure blood pressure, and the oximetry was used to measure the patient's heart rate and oxygen saturation. Both tools have been calibrated. The instrument used to assess GCS following the Bahrudin theory (2011) used three components including eye, verbal, and motoric responses [9].

The researcher provides questionnaire sheets containing questions about the respondent's characteristics. The researcher also measured blood pressure, calculated heart rate, respiratory rate, body temperature, oxygen saturation, and assessed the Glasgow Coma scale. The results were recorded on the observation sheet. The whole data collection process maintaining the confidentiality of respondent identity. The collected data given a code, tabulated, and analyzed by a bivariate & multivariate analytical test. The study was approved by ethical clearance Reg. no: 590/KEPK-POLKESMA/2020.

RESULTS

Table 1 shows the average of the respondent's age was 39 years old. Table 2 shows the majority were male (N = 19, 63%) with the respondent's profession were students (N = 8, 27%), and most of the leading causes of trauma due to traffic accidents (N = 26, 87%).

Table 4 shows there was a significant correlation between mean arterial pressure (MAP) and Glasgow coma scale (GCS) ($p = .004$; p-value <.05) and H_0 is rejected. The correlation value ($r = .505$) showed a positive correlation with moderate correlation strength. The decreasing value of MAP will decrease the value of GCS.

The Spearman's rho test result between the patient's heart rate and GCS obtained a $p = .135$ (p-value> .05) which means that H_0 is accepted. Spearman correlation value ($r = -.279$) shows a negative correlation with a weak correlation strength, and there was no correlation between heart rate and GCS among head injury patients.

The Spearman's rho test result between respiratory rate and GCS obtained a $p = .000$ (p-value <.05) which means that H_0 is rejected. Spearman correlation value ($r = -.598$) shows a negative correlation with moderate correlation strength, and there was a significant correlation between the respiratory rate and GCS among head injury patients. The increasing value of respiratory rate will decrease the value of GCS.

The body temperature and GCS obtained p = .000 (p-value <.05) which means that H0 is rejected. Spearman correlation value (r = -.432) shows a negative correlation with weak correlation strength. It can be defined that there was a significant correlation between body temperature and GCS among head injury patients. The increase in body temperature value will decrease the GCS value.

Regarding the Spearman's rho test result between oxygen saturation and GCS obtained a p = .000 (p-value <.05) which means that H_0 is rejected. Spearman correlation value (r = .812) shows a positive correlation with strong correlation strength. It can be defined that there was a significant correlation between oxygen saturation and GCS among head injury patients. The increasing value of oxygen saturation will increase GCS value.

Table 1
The age distribution of the study participant

Variable	N	Mean	Min	Max	SD
Age	30	39,43	18	78	17,719

Table 2
The characteristics distribution of the study participant

Distribution	Frequency (N)	Percentage
Gender		
Male	19	63%
Female	11	37%
Total	30	100%
Profession		
House wife	4	14%
Student	8	27%
Employee	4	14%
Farmer	6	20%
Entrepreneur	4	14%
Driver	1	1%
Builder	3	10%
Total	30	100%
The Leading Caused of Trauma		
Traffic accident	26	87%
Fell down	4	13%
Total	30	100%

Table 3
The values of hemodynamic status, oxygen saturation, and GCS

Variable	Min.	Max.	Med	Mean	SD
MAP	63.3	106.60	83.00	83.09	10.46
Heart rate	68	120	85.50	87	11.36
Respiratory rate	18	27	21	21	2.24
Body temperature	36.00	38.50	36.80	36.92	.74
Oxygen saturation	88	99	97	96	2.79
GCS	13	15	12	11.20	3.91

MAP: Mean Arterial Pressure; GCS: Glasgow Comma Scale

Table 4
The result of correlation analysis (Spearman's rho test)

	Correlation Coefficient	p-value
MAP-GCS	.505	.004**
Heart Rate-GCS	-.279	.135
Respiratory Rate-GCS	-.598	.000**
Body Temperature-GCS	-.432	.017*
SpO_2-GCS	.812	.000**

MAP: Mean Arterial Pressure; GCS: Glasgow Comma Scale; *ρ<.05 **ρ<.01

DISCUSSION

Correlation between Mean Arterial Pressure (MAP) and Glasgow Coma Scale (GCS) in Head Injury Patients

The findings showed there was a significant correlation between MAP and GCS in head injury patients with moderate correlation strength. Based on table 4, it showed that the mean of the MAP is 86.733 mmHg with a minimum value of 63.3 mmHg and a maximum value of 110 mmHg. The normal value of MAP is 70-100 mmHg [10]. The MAP mean was still within normal limits. However, respondents who experienced moderate to severe head injuries had a lower MAP.

The results of this study are supported by previous research that discussess the critical value of mean arterial pressure ability to detect the level of consciousness in head injury patients by 77.8% with a regression coefficient of variable mean arterial pressure (X) of 1.012. The study result shows that if the mean arterial pressure has increased 1, then the level of consciousness (Y) will be increased by 1.012. It means the increasing value of mean arterial pressure will increase the level of consciousness [5].

The researcher assumes that among the moderate to severe head injuries patients, the risk of brain hemorrhage is higher. In case there was bleeding in the brain, the risk of increased intracranial pressure also increases. The cerebral perfusion pressure was calculated from the difference between MAP and intracranial pressure. Consequently, when intracranial pressure is high, and not balanced with adequate arterial pressure, the cerebral perfusion pressure decreases. Inadequate cerebral perfusion pressure results in decreased consciousness.

Correlation between Heart Rate and Glasgow Coma Scale (GCS) in Head Injury Patients

The finding showed there was no correlation between heart rate and GCS in head injury patients. The mean heart rate in this study was 87 times per minute, the normal value of the heart rate was 60~100 times per minute [10]. The heart rate mean was still within normal limits. The results of this study were in line with the results of Suwaryo, Wihastuti, and Fathoni (2016) research found that the pulse does not have a significant relationship to the outcome of head injury patients with modest relationship strength. This was due to the productive age of the hormonal system which tends to be more stable [11].

On the other hand, according to research by Reisner et al. (2014) found the positive predictive value of the Glasgow Coma Scale in high mortality brain injury state was the prehospital heart rate, and it had a significant relationship with AIS 5~6. The Abbreviated Injury Scale (AIS) is the basis for assessing the severity of the head injury. Similarly, while the AIS value is low, the GCS is also low [12].

Researchers assume the patient's heart rate is influenced by internal and external factors of the patient. Age becomes the internal factor which has contribution to the GCS of patients. Presented in Table 1, the majority of respondents were in a productive period with an average age of 39 years old. During the productive age, the systemic condition of the body still reaches the optimal function. Besides, the heart rate and blood pressure were measured one time when the patient was in the emergency room. The ability of cells in humans at a productive age more easily experience recovery or repair and formation of new cells.

Correlation between Respiratory Rate and Glasgow Coma Scale (GCS) in Head Injury Patients

The results of the study showed that there was a significant correlation between respiratory rate and GCS in head injury patients with moderate correlation strength. In this study, the mean respiratory rate was 21 breaths per minute with a minimum value of 18 breaths per minute and a maximum value of 27 breaths per minute. The results of this study were in line with the results of Ristanto et al. (2016) when the respiratory rate was less than 12 breaths per minute or more than 24 breaths per minute will increase mortality or poor outcomes in head injury patients [13]. The alteration of respiratory rate may cause decreased oxygen saturation in the blood followed by the decrease of cerebral tissue perfusion [14]. Low cerebral tissue perfusion resulted in increased intracranial pressure and cerebral hypoxia [13].

In the early phase after a head injury, the body will try to maintain oxygen saturation by increasing the respiratory rate (hyperventilation) [13]. Hyperventilation reduces the partial pressure of carbon dioxide ($PaCO_2$) in the blood, resulting in vasoconstriction of blood vessels cause limited blood flow to the brain. Decreased blood flow to the brain results in decreased consciousness [15].

Researchers assume an increase in respiratory rate is the body's compensation for maintaining blood oxygen levels to preserve the cerebral tissue perfusion. It is expected that increasing the respiratory rate will increase FiO_2 and also have an impact on increasing PaO_2 and SpO_2. In case the compensation fails, the oxygen saturation level will decrease then the patient will fall into a state of hypoxia- related to secondary brain injury. Either tt lowering the patient's level of consciousness.

Correlation between Body Temperature and Glasgow Coma Scale (GCS) in Head Injury Patients

The results of the study showed that there was a significant correlation between body temperature and GCS in head injury patients with weak correlation strength. It is found the mean body temperature of the respondents was 36.9^0C. The normal value of body temperature for adults is 36.5^0C - 37.5^0C [16]. Respondents who experienced an increase in body temperature were mostly patients with severe head injuries. This is following the opinion that head injury patients often experience an increase in body temperature [17].

In this study, the respondent's body temperature was measured when the respondent first came to the emergency room and was not followed up. Whereas in some theories, body temperature can increase 24~48 hours after trauma [18]. This allows that post-head injury does not directly increase body temperature.

The finding was in line with research conducted by Rahmawati, et al. (2013) about the correlation between body temperature and the Revised Trauma Score (RTS) in head injury patients. RTS value found to be associated with predictors of death, the lower the RTS value the higher the risk of death of the patient [17]. Other research that supports the finding was the research by Suwaryo, Wihastuti, and Fatoni (2016) that mentioned on body temperature had a significant correlation with the outcome of head injury patients [11].

Researchers assumed that not every head injury patient has an increase in body temperature as evidenced by the weak correlation value. Following the theory and the results of several studies, an increase in body temperature may cause an elevation in intracranial pressure and cause a decrease in consciousness, but this has no direct effect. Increased body temperature is a manifestation of increased metabolism. The severity of the head injury and the length of time response to treatment was other factors that influence the thermoregulatory response.

Correlation between Oxygen Saturation and Glasgow Coma Scale (GCS) in Head Injury Patients

The results of the study showed there was a significant correlation between oxygen saturation and GCS in head injury patients with strong correlation strength. It is found the mean SpO_2 was 96% with a minimum value of 88% and a maximum value of 97%. The finding was in line with the research of Ristanto & Zakaria (2017) on the relationship between respiratory frequency (RR) and oxygen saturation (SpO_2) in head injury patients, the decrease in patient GCS will be followed by a decrease in the patient's SpO_2 [13].

Head injury patients need an adequate oxygen supply to meet the metabolic needs of the brain. Cerebral hypoxia characterized by a decrease in oxygen saturation can trigger an ischemic process in cerebral tissue [19]. Cerebral tissue hypoxia will increase the risk of secondary trauma to the brain tissue which will result in high mortality cases among patients with head injury [13]. The finding was in line with research conducted by Ristanto and Zakaria (2017) on the accuracy of oxygen saturation as a predictor of mortality in head injury patients which mentioned that an increasing SpO_2 will further reduce the incidence of mortality in head injury patients [13]. The result of another study conducted by Putra et al. (2016) showed the value of oxygen saturation influenced the mortality of head injury patients with a negative direction of correlation. Any decrease in oxygen saturation value will be followed by an increased risk of death in head injury patients

[1]. Therefore, monitoring oxygen saturation is one of the main determinants of oxygen supply in the blood to all body tissues, especially cerebral tissues also to prevent and recognize the risk for cerebral tissue hypoxia [20].

Researchers assume the condition of hypoxia was the impact of the severity of brain damage after head injury which was reflected from the patient's GCS score. Hypoxia occurs when insufficient oxygen flowed into the body's tissues, especially the cerebral. In this situationof the body failed to compensate, it will trigger an ischemic process of the cerebral tissue and increases the risk for a secondary head injury which can further reduce the level of consciousness.

CONCLUSION

The conclusion of this study there was a significant correlation between MAP, respiratory rate, body temperature, and oxygen saturation with the level of consciousness.

The study results can be used as a recommendation in nursing practice, especially concerning the emergency nurses to monitoring the patient’s hemodynamic status and oxygen saturation. Moreover, to prevent and anticipate bad prognosis and improve the quality of professional health services including responsive, fast and appropriate services for head injury patients.

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