Changes In SGOT/SGPT, Albumin and NLR Values as Predictors of The Severity of Blunt Hepatic Trauma in RSUP Prof. Dr I.G.N.G Ngoerah Denpasar

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ABSTRACT

Objective: To determine the relationship of SGOT/SGPT, serum albumin levels and neutrophil lymphocyte ratio with the degree of major hepatic trauma. *Methods:* This study used a retrospective cohort observational research design. Samples in this study were selected by consecutive sampling by selecting subjects where all subjects who met the selection criteria in the period January 2019-December 2022. This study involved 66 samples of hepatic blunt trauma patients who were treated at Prof. Dr. I.G.N.G. Ngoerah Hospital Denpasar. *Results:* SGOT enzyme has a p-value of 0.047 <0.05, SGPT enzyme obtained data with a p-value of 0.056>0.05, albumin levels with a p-value of 0.011 <0.05 and NLR with a p-value of 0.022 <0.05. Based on the OR value, it can be concluded that NLR > 6.3 can cause major trauma 21.2 times and is the most dominant variable causing major hepatic trauma. *Conclusion:* Increase in SGOT enzyme level > 318.2 U/L, increase in SGPT enzyme level > 186.15 U/L, decrease in serum albumin level < 3.02 and increase in neutrophil lymphocyte ratio (NLR) level > 6.3 103/ul are significant as predictors of major hepatic trauma. NLR is the most dominant factor in the severity of hepatic trauma compared to the increase in SGOT/SGPT enzyme levels and decreased serum albumin levels.

Keywords: predictors; blunt hepatic trauma; SGOT/SGPT; albumin; NLR

INTRODUCTION

Trauma is one of the main causes of hospitalization and a global health problem. The World Health Organization (WHO) estimates that by 2020, trauma will be the leading or second leading cause of lost years of productive life in the world's population. Abdominal trauma is an emergency condition that is the third leading cause of death in trauma patients and can be found in about 7-10% of all trauma cases (Alghamdi., 2017). The incidence of blunt hepatic trauma is found to be around 85% of all abdominal trauma. The general cause of trauma in Indonesia is caused by motorcycle accidents and falls with the highest prevalence of trauma found in the age group of 15-24 years. So, this place blunt abdominal trauma as one of the problems that will be faced by all health workers in general and surgeons in particular (Karjosukarso et al., 2019).

Several studies have demonstrated the usefulness of performing simple laboratory tests, such as estimating serum transaminase levels, to identify the presence of hepatic trauma in abdominal trauma. This is based on the presumptive understanding that during hepatic trauma, transaminases stored in hepatocytes are released into the bloodstream, resulting in elevated levels, the presence of which can be determined by performing a simple blood test (Zachariah et al., 2018).

Abnormal ALT and AST can predict the presence of hepatic trauma in abdominal trauma patients, while the degree of abnormality can determine the severity of hepatic damage and ALT is more specific for hepatic trauma than AST although AST shows high sensitivity for hepatic trauma than ALT (Elbaih et al., 2016).

Trauma in the liver will also affect albumin levels. Trauma causes damage to blood vessels, leading to loss of albumin and hemoglobin. Serum albumin at first admission is more dominant as a biological variable in predicting in-hospital mortality (Luo et al., 2019).

When trauma occurs, there will be an inflammatory process involving neutrophils. Neutrophils destroy microorganisms in several ways including phagocytosis, secreting antimicrobial substances, formation of neutrophil extracellular traps (NETs). Neutrophil activation also induces the release of proteinases into surrounding tissues, resulting in damage to the host. Neutrophils are capable of producing many cytokines and chemokines that influence the inflammatory response as well as the immune response (Uribe-querol & Rosales, 2015).

METHODS
Design, time, and place of the study
This study uses a retrospective cohort observational research design, the aim is to see if there is a relationship between the independent variable and the dependent variable. Researchers observed and traced cases of abdominal trauma and then explored patients with hepatic trauma through the medical records of patients admitted to Prof. Dr. I.G.N.G. Ngoerah Hospital during the period 2019 to 2022. Then the researchers evaluated the age of gender, SGOT, SGPT levels, albumin levels and neutrophil lymphocyte ratio.

Sample characteristics
The target population in this study were all patients admitted to Prof. Dr. I.G.N.G. Ngoerah Hospital with abdominal trauma. The affordable population in this study were all patients with a diagnosis of blunt hepatic trauma who were admitted to Prof. Dr. I.G.N.G. Ngoerah Hospital from January 2019 - December 2022. The sample of this study is part of the affordable population with the amount in accordance with the minimum sample calculation, fulfilling the inclusion criteria and exclusion criteria of the study.

Data analysis
Before analyzing the data, a data completeness check was first carried out. The research analysis was carried out with several stages of data analysis consisting of:

1. Descriptive analysis
This analysis was conducted to obtain the characteristics of the research subjects and the frequency distribution of various variables in the form of a single table. Categorical scales are expressed as frequency distribution and percentage, while numerical scales are expressed as mean and standard deviation (SD).

2. Data normality test
Before bivariate analysis, data were analyzed classical prerequisites such as data normality test using Shapiro wilk and data homogeneity using levene test. Data normality aims to determine whether the data distribution is normally distributed or not at a level of significance of 0.05, where the data is declared normal if $p > 0.05$ and declared abnormal if $p \leq 0.05$. Data variance is declared homogeneous if $p > 0.05$.

3. Bivariate analysis
Bivariate analysis was performed to determine the difference in mean SGOT and SGPT levels, serum albumin levels and NLR between major and minor hepatic trauma for numerical data using the independent t-test if the data were normally distributed and the Mann Whitney U test if the data were not normally distributed with a 95% confidence interval and an accepted significance limit with a p value <0.05. To obtain the Odd Ratio value, the data were analyzed by presenting data on SGOT and SGPT levels, serum albumin levels and NLR in categorical form, namely SGOT / SGPT levels and NLR in the form of high and normal and albumin levels in the form of normal and low so that cross tabulation analysis can be carried out using a 2x2 table.

4. Multivariate Analysis
Multivariate analysis aims to analyze independent variables, namely SGOT and SGPT levels, serum albumin levels and NLR by controlling age, gender and BMI using logistic regression test so that the adjusted OR value is obtained with a 95% confidence interval and significance p value <0.05.

RESULTS
Characteristics of the study
This study used 66 medical records of patients with blunt hepatic trauma who were treated at Prof. Dr. I.G.N.G. Ngoerah Hospital in the period January 2019-December 2022. Respondent characteristics were described based on age, gender, SGOT SGPT enzyme levels, Albumin and NLR against the severity of blunt hepatic trauma. The data is presented in Table 5.1.

TABLE 5.1: Respondent Characteristics.

Characteristics	Degree of severity blunt trauma of the liver		p-value
	Major Trauma (n=46)	Minor trauma (n=20)	
Age (mean±SD)	27,5±13,1	31,2±18,8	0,764
Gender Male Female	38(57,6%) 8 (12,1%)	15 (22,7%) 5 (7,6%)	0,475
SGOT Enzyme Level (mean±SD)	653,83±390,8	192,4±179,4	0,000
SGPT Enzyme Levels (mean±SD)	482,9±347,49	135,7±186,3	0,000
Albumin levels (mean±SD)	2,5±0,6	3,3±0,5	0,000
Neutrophil lymphocyte ratio (mean±SD)	13,2±8,9	4,7±3,8	0,000

Table 5.1 shows the mean age between the major trauma group and minor hepatic trauma there is no difference p-value> 0.05 while based on gender obtained more men than women but based on gender there is no difference between the myor hepatic trauma group and minor hepatic trauma.

Based on the research variables, the SGOT enzyme level of major hepatic trauma was found to be 653.83 (SD: 390.8) while minor hepatic trauma was found with a mean of 192.4 (SD: 179.4). Males were found to have more major trauma 38 people (57.6%). SGPT enzyme levels in the major hepatic trauma group were found with a mean of 482.9 (SD: 347.49) while minor hepatic trauma was found with a mean of 135.7 (SD: 186.3). Albumin levels in major hepatic trauma were found with a mean of 2.5 (SD: 0.6) while minor hepatic trauma was found with a mean of 3.3 (SD: 0.5).

Neutrophil lymphocyte ratio levels in major hepatic trauma were found with a mean of 13.2 (SD: 8.9) while in minor trauma it was found with a mean of 4.7 (SD: 3.8). The p-value of sgot enzyme levels, sgpt enzyme levels, albumin levels, and neutrophil lymphocyte ratio with a value <0.05.

SGOT and SGPT Enzyme Levels Against the Degree of Severity of Blunt Trauma of the Hepar
The levels of SGOT and SGPT enzymes in this study were determined based on the ROC curve so that the AUC value and cutt off points were obtained. ROC curve assessment based on the area under ROC curve is stated when ≥70%. Then find the cut-off point of the SGOT and SGPT enzymes to predict the occurrence of major hepatic trauma by determining the farthest coordinate point of the ROC curve. The results of the analysis based on the ROC curve and AUC values are presented in Figure 5.1 and Table 5.2.
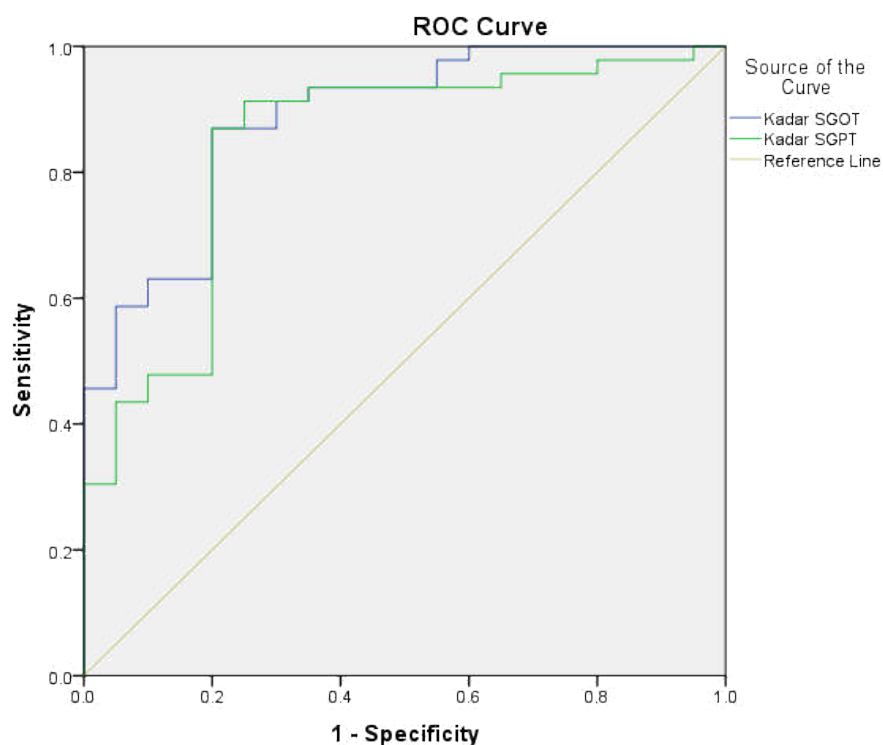

FIGURE 5.1: SGOT SGPT ROC Curve Image.

Furthermore, SGOT and SGPT obtained AUC values with 95% confidence intervals and p-values.

TABLE 5.2: AUC values of SGOT and SGPT.

Variable	AUC Value	IK 95%	*p*-value
SGOT enzymes	88,4%	0,798-0,969	0,000
SGPT enzymes	84%	0,730-0,950	0,000

Table 5.2 shows that the SGOT enzyme data obtained an AUC value of 88.4% and the SGPT enzyme obtained an AUC value of 84%. This means that if SGOT and SGPT are used to determine the severity of hepatic trauma in 66 respondents, the correct conclusion is obtained using SGOT enzymes in 58 patients and SGPT enzymes in 56 patients. Clinically, the AUC value of SGOT and SGPT is very satisfying because it is greater than the minimum AUC value expected by researchers which is 70%. Furthermore, based on the coordinate of the curve value using excel, the cut of point value of SGOT is 318.2 and SGPT is 186.15. Based on the cut of points analyzed using the 2x2 table presented in table 5.3.

TABLE 5.3: SGOT and SGPT Levels for Hepar Trauma.

Variable	Hepar Trauma		OR	IK95%	*p*-value
	Major Trauma	Minor Trauma			
SGOT					
Cut of >318,2 U/L	38(57,6%)	4(6,1%)	19	5-72,18	0,000
Cut of ≤ 318,2 U/L	8(12,1%)	16 (24,2%)			
SGPT					
Cut of >186,15 U/L	37(56,1%)	4(6,1%)	16,4	4,41-61,29	0,000
Cut of ≤ 186,15 U/L	9(13,6%)	16(24,2%)			

Table 5.3 shows that SGOT > 318.2 U/L with major hepatic trauma were 38 respondents (57.6%) and minor trauma were 4 (6.1%) respondents while SGOT ≤ 318.2 with major hepatic trauma were 8 respondents (12.1%) and minor trauma were 16 respondents (24.2%). Based on the 2x2 table, the OR value was 19 with a p-value of 0.000 <0.05 (IK: 5-72.18). These results indicate that SGOT > 318.2 U/L increases the risk of major hepatic trauma by 19 times.

SGPT > 186.15 U/L with major hepatic trauma were 37 respondents (56.1%) and minor trauma were 4 (6.1%) respondents while SGPT ≤ 186.15 with major hepatic trauma were 9 respondents (13.6%) and minor trauma were 16 respondents (24.2%). Based on the 2x2 table, the OR value was 16.4 with a p-value of 0.000 <0.05 (IK: 4.41-61.29). These results indicate that SGPT > 186.15 U/L increases the risk of major hepatic trauma by 16.4 times.

Patient Serum Albumin Levels Can Be a Predictor of the Severity of Blunt Trauma to the Hepar
Albumin levels in this study were determined based on the ROC curve so that the AUC value and cutt off points were obtained. The results of the analysis based on the ROC curve and AUC values are presented in Figure 5.2 and Table 5.4.
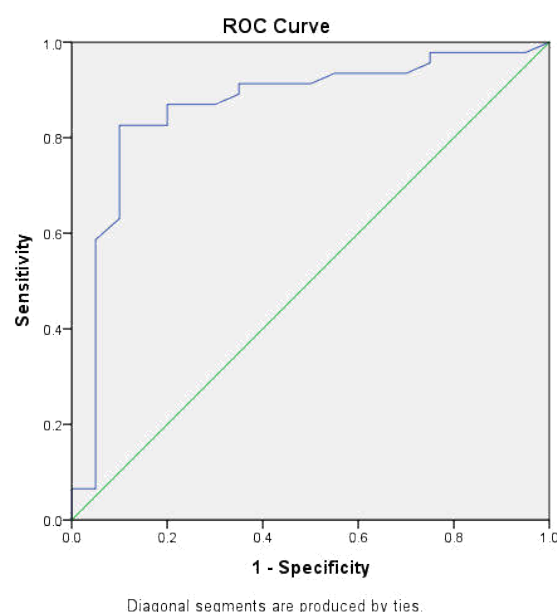

FIGURE 5.2: Albumin Level ROC Curve.

Furthermore, albumin levels obtained AUC values with 95% confidence intervals and p-values.

TABLE 5.4: AUC Values of Albumin Levels.

Variable	AUC Value	IK 95%	*p*-value
Albumin Level	86,3%	0,756-0,970	0,000

Table 5.4 shows the albumin level data obtained an AUC value of 86.3%, meaning that if albumin is used to determine the severity of hepatic trauma in 66 respondents, the correct conclusion is obtained using albumin in 57 patients. Clinically, the AUC value of albumin is very satisfying because it is greater than the minimum AUC value expected by researchers, which is 70%. Furthermore, based on the coordinate value of the curve using excel, the albumin cut of point value is 3.02. Based on the cut of points analyzed using the 2x2 table presented in Table 5.5.

TABLE 5.5: Albumin levels against hepatic trauma.

Variable	Hepar Trauma		OR	IK95%	*p*-value
	Major Trauma	Minor Trauma			
Albumin					
Cut of <3,02 gr/dl	39(59,1%)	4(6,1%)	22,2	5,72-86,77	0,000
Cut of ≥ 3,02 gr/dl	7(10,6%)	16 (24,2%)			

Table 5.5 shows Albumin < 3.02 gr/dl with major hepatic trauma as many as 39 respondents (59.1%) and minor trauma as many as 4 (6.1%) respondents while Albumin ≥ 3.02 gr/dl with major hepatic trauma as many as 7 respondents (10.6%) and minor trauma as many as 16 respondents (24.2%). Based on the 2x2 table, the OR value was 22.2 with a p-value of 0.000 <0.05 (IK: 5.72-86.77). These results indicate that Albumin < 3.02 gr/dl increases the risk of major hepatic trauma by 22.2 times.

Patient's NLR Level as a Predictor of the Severity of Blunt Trauma to the Hepar

The NLR level in this study was determined based on the ROC curve to obtain the AUC value and cutt off points. The results of the analysis based on the ROC curve and AUC values are presented in Figure 5.3 and Table 5.6.
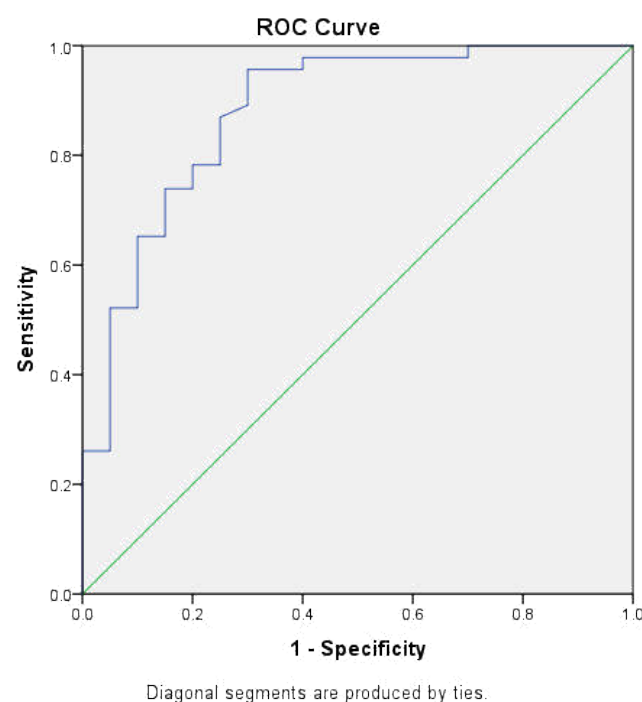

Diagonal segments are produced by ties.

FIGURE 5.3: ROC curve of Neutrophil Lymphocyte Ratio.

Furthermore, Neutrophil Lymphocyte Ratio obtained AUC value with 95% confidence interval and p-value.

TABLE 5.6: AUC values of Neutrophil Lymphocyte Ratio Levels.

Variable	AUC Value	IK 95%	*p*-value
NLR Level	88,1%	0,786-0,976	0,000

Table 5.6 shows the data on NLR levels obtained an AUC value of 88.1%, meaning that if NLR is used to determine the severity of hepatic trauma in 66 respondents, the correct conclusion is obtained using NLR in 58 patients.

Clinically, the AUC value of NLR is very satisfying because it is greater than the minimum AUC value expected by researchers which is 70%. Furthermore, based on the coordinate of the curve value using excel, the NLR cut of point value was obtained at 6.3. Based on the cut of points analyzed using the 2x2 table presented in table 5.7.

TABLE 5.7: Neutrophil Lymphocyte Ratio for Hepar Trauma.

Variable	Hepar Trauma		OR	IK95%	*p*-value
	Major Trauma	Minor Trauma			
NLR Cut of > 6,3 10^3/ul Cut of ≤ 6,3 10^3/ul	40(60,6%) 6(9,1%)	8(12,1%) 12 (18,2%)	10	2,89-34,54	0,000

Table 5.7 shows Neutrophil Lymphocyte Ratio > 6.3 103/ul with major hepatic trauma as many as 40 respondents (60.6%) and minor trauma as many as 8 (12.1%) respondents while Neutrophil Lymphocyte Ratio Cut of ≤ 6.3 103/ul with major hepatic trauma as many as 6 respondents (9.1%) and minor trauma as many as 12 respondents (18.2%). Based on the 2x2 table, the OR value was 10 with a p-value of 0.000 <0.05 (IK: 2.89-34.54). These results indicate that Neutrophil Lymphocyte Ratio > 6.3 103/ul increases the risk of major hepatic trauma by 10 times.

Multivariate Analysis Results
Multivariate analysis is carried out to see the effect between variables involving more than 2 variables

and the data scale used is categorical with logistic regression test. The logistic regression test goes through several stages to state that the test model can be carried out. In the omnibus test table, the p-value <0.05 is obtained, which means that the test model can be continued because the independent variable affects the dependent variable (attachment). In the Hosmer and Lameshow test, the p-value> 0.05 is obtained, which means that this test is fit for use (attachment). The classification table obtained 92.4%, which means that the test model used in predicting the independent variable on the dependent variable is 92.4%. The final results of the variables in the equation are presented in Table 5.8.

TABLE 5.8: Enzyme Levels of SGOT SGPT, Albumin and NLR against Major Trauma of the Hepar.

Variable	B	Adj (OR)	95%CI	*p*-value
SGOT enzymes > 318,25 U/L	2,595	13,4	1,03-174,11	0,047
SGPT enzymes >186,15 U/L	2,526	12,5	0,93-167,25	0,056
Albumin Level <3,02 gr/dl	2,755	15,7	1,89-130,54	0,011
Neutrophil lymphocyte ratio >6,3 10^3/ul	3,058	21,2	1,53-294,54	0,022

The description of table 5.8 shows that the variables entered together are then selected so that the data obtained for all variables have a positive B value, meaning that the independent variables have a positive relationship with the occurrence of major hepatic trauma.

SGOT enzyme has a p-value of 0.047 <0.05, SGPT enzyme obtained data with a p-value of 0.056>0.05, albumin levels with a p-value of 0.011 <0.05 and NLR with a p-value of 0.022 <0.05. Based on the OR value, it can be concluded that NLR > 6.3 can cause major trauma 21.2 times and is the most dominant variable causing major hepatic trauma.

DISCUSSION
Characteristics of Respondents
The results showed that major hepatic trauma (69.7%) was more than minor hepatic trauma with an average age of 27.5 years and 31.2 years and occurred more in men. In line with Karjosukarso et al (2019) who stated that the incidence of blunt hepatic trauma was found to be around 85% of all abdominal trauma. The cause of trauma in general in Indonesia is caused by motorcycle accidents and falls with the highest prevalence of trauma found in the age group 15-24 years. Hepatic trauma is the main cause of death in abdominal trauma, and blunt abdominal trauma is still significantly related to patient morbidity and mortality due to hemorrhagic shock (Boese et al., 2015; Mulyadi et al., 2020).

SGOT and SGPT Enzyme Levels and Severity of Blunt Trauma to the Hepar
The results showed that SGOT and SGPT enzyme levels were predictors of major hepatic trauma. SGOT > 318.2 U/L increased the risk of major hepatic trauma by 19 times and SGPT > 186.15 U/L increased the risk of major hepatic trauma by 16.4 times. Several studies have shown the usefulness of performing simple laboratory tests, such as estimating serum transaminase levels, to identify the presence of hepatic trauma in abdominal trauma. This is based on the presumptive understanding that during hepatic trauma, transaminases stored in hepatocytes are released into the bloodstream, resulting in elevated levels, the presence of which can be determined by performing a simple blood test (Zachariah et al., 2018).

Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT) are hepatic enzymes that increase in peripheral blood in relation to hepatic trauma. Studies in children found with blunt hepatic trauma and AST and ALT levels ≤ 50 IU/L did not require action. These findings suggest that AST and ALT could be included in the management algorithm as a screening method to avoid abdominal CT (Bruhn et al., 2016).

Patient Serum Albumin Level as a Predictor of Severity of Blunt Trauma of the Hepar
The results showed that a decrease in serum albumin as a predictor of hepatic trauma severity. Albumin levels <3.02 gr/dl increase the risk of major hepatic trauma by 22.2 times. Trauma to the hepar will affect albumin levels. Albumin is synthesized in hepatocyte cells, about 10-15 grams of albumin is produced and released into the blood vessels every day. In the blood, albumin has a half-life of 19 days, this is mainly due to the presence of Fc receptor (FcRn)-mediated recycling, and Megalin/Cublin-complex.

The termination of albumin results from catabolism in skin and muscle organs (Larsen et al., 2016). There are several causes of hypoalbuminemia, namely the loss of serum albumin associated with bleeding. Trauma causes damage to blood vessels, leading to loss of albumin and hemoglobin. Increased vascular permeability will encourage a greater shift of albumin from vascular to interstitial (Corrigan et al., 2016).

The Chou et al (2023) study found a significantly lower bilirubin albumin level of 2.8 as a significant independent risk factor for mortality with an OR, 2.79. This study suggests that albumin level is a significant independent risk factor and a useful clinical tool for finding liver injuries that are more prone to death (Chou et al., 2023). Hypoalbuminemia was independently associated with mortality, being associated with a decrease in 14 ventilation-free days, 14 ICU-free days, and 28 hospital-free days. Serum albumin at first admission was more dominant as a biological variable in predicting in-hospital mortality (Luo et al., 2019).

Neutrophil Lymphocyte Ratio Levels on the Severity of Blunt Trauma of the Hepar
The results showed NLR as a predictor of hepatic trauma severity. Neutrophil Lymphocyte Ratio > 6.3 103/ul increases the risk of major hepatic trauma by 10 times and the results of multivariate analysis show that NLR causes major trauma 21.2 times and is the most dominant variable causing major hepatic trauma. When trauma occurs, there will be an inflammatory process involving neutrophils. Neutrophil activation induces the release of proteinases into surrounding tissues, resulting in damage to the host. Neutrophils are capable of producing many cytokines and chemokines that influence the inflammatory response as well as the immune response (Uribe-querol & Rosales, 2015).

CONCLUSIONS
Increase in SGOT enzyme level > 318.2 U/L, increase in SGPT enzyme level > 186.15 U/L, decrease in serum albumin level < 3.02 and increase in neutrophil lymphocyte ratio (NLR) level > 6.3 103/ul are significant as predictors of major hepatic trauma. NLR is the most dominant factor in the severity of hepatic trauma compared to the increase in SGOT/SGPT enzyme levels and decreased serum albumin levels.

REFERENCES
[1] Afifi, I., Abayazeed, S., El-Menyar, A., Abdelrahman, H., Peralta, R., & Al-Thani, H. (2018). Blunt liver trauma: A descriptive analysis from a level i trauma center. BMC Surgery, 18(1), 1–9. https://doi.org/10.1186/s12893-018-0369-4

[2] Alghamdi, H. M. (2017). Management of liver trauma. Saudi Journal of Medicine Science, 74(8), 432–438. https://doi.org/10.12968/hmed.2013.74.8.432

[3] Anthony J, B. (2020). Imaging Modality and Management of Hepatic Injury in the Trauma Setting. Trauma Cases and Reviews, 6(1), 1–7. https://doi.org/10.23937/2469-5777/1510080

[4] Arora, B., Arora, R., & Arora, A. (2016). Conservative treatment of blunt hepatic trauma: my experience. International Surgery Journal, January, 2155–2159. https://doi.org/10.18203/2349-2902.isj20163591

[5] Arumugam, S., Al-Hassani, A., El-Menyar, A., Abdelrahman, H., Parchani, A., Peralta, R., Zarour, A., & Al-Thani, H. (2015). Frequency, causes and pattern of abdominal trauma: A 4-year descriptive analysis. Journal of Emergencies, Trauma, and Shock, 8(4), 193.

[6] Avash Kalra, Wedd, J. P., Bambha, K. M., Gralla, J., Collins, L. G.-M. C., Rosen, H. R., & Biggins, S. W. (2017). Neutrophil-to-Lymphocyte Ratio Correlates with Proinflammatory Neutrophils and Predicts Death in Low Model for End-Stage Liver Disease Patients with Cirrhosis. Liver Transp, 23(2), 155–165. https://doi.org/10.1002/lt.24702.Neutrophil-to-Lymphocyte

[7] Azab, B., Camacho-rivera, M., & Taioli, E. (2014). Average Values and Racial Differences of Neutrophil Lymphocyte Ratio among a Nationally Representative Sample of United States Subjects. PLOS ONE, 9(11), 1–6. https://doi.org/10.1371/journal.pone.0112361

[8] Blunt, M. C., Nicholson, J. P., & Park, G. R. (1998). Serum albumin and colloid osmotic pressure in survivors and nonsurvivors of prolonged critical illness. Anaesthesia, 53, 755–761. https://doi.org/doi:10.1046/j.1365-2044.1998.00488.x.

[9] Boese, C. K., Hackl, M., Müller, L. P., Ruchholtz, S., Frink, M., & Lechler, P. (2015). Nonoperative management of blunt hepatic trauma: A systematic review. Journal of Trauma and Acute Care Surgery, 79(4), 654–660. https://doi.org/10.1097/TA.00000000000008 14

[10] Brillantino, A., Iacobellis, F., Festa, P., Mottola, A., Acampora, C., Corvino, F., Del Giudice, S., Lanza, M., Armellino, M., Niola, R., Romano, L., Castriconi, M., De Palma, M., & Noschese, G. (2019). Non-Operative Management of Blunt Liver Trauma: Safety, Efficacy and Complications of a Standardized Treatment Protocol. Bulletin of Emergency and Trauma, 7(1), 49–54. https://doi.org/10.29252/beat-070107

[11] Brown, R. M., & Semler, M. W. (2020). HHS Public Access. Journal Intensive Care Med, 34(5), 364–373. https://doi.org/10.1177/ 0885066618784861.Fluid

[12] Bruhn, P. J., Østerballe, L., Hillingsø, J., Svendsen, L. B., & Helgstrand, F. (2016). Posttraumatic levels of liver enzymes can reduce the need for CT in children: A retrospective cohort study. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 24(1), 1–5. https://doi.org/10.1186/s13049-016-0297-1

[13] Cahyono, S. B. (2019). Evaluation of Increased Serum Aminotransferase Level in Asymptomatic Patient. The Indonesian Journal of Gastroenterology, Hepatology, and Digestive Endoscopy, 12(2), 109–115.

[14] Chae, Y. J., Lee, J., Park, J. H., Han, D., Ha, E., & Yi, I. K. (2021). Late Mortality Prediction of Neutrophil-to-Lymphocyte and Platelet Ratio in Patients with Trauma Who Underwent Emergency Surgery: A Retrospective Study. Journal of Surgical Research, 267, 755–761. https://doi.org/10.1016/j.jss.2020.11.088

[15] Chang, C. H., Lin, H. J., Liao, Y. Y., Chu, F. Y., & Chen, K. T. (2013). Elevated aminotransferases are predictors of hepatic injury in blunt abdominal trauma patients. Hong Kong j. Emerg. Med, 20(6), 337–343. https://doi.org/10.1177/102490791302000602

[16] Chaudhry, R., & Verma, A. (2020). Recent Trends in Management of Liver Trauma. Indian Journal of Surgery. https://doi.org/10.1007/s12262-019-02056-2

[17] Che Jusoh, A., Najmuddin Ghazi, F., & Muizz Rasidi, A. (2016). Triple elevation of ALT is indicative of blunt hepatic trauma. Our local experience at rural district hospital. Global Surgery, 2(1), 81–83. https://doi.org/10.15761/gos.1000125

[18] Chien, L., Lo, S., & Yeh, S. (2013). Incidence of liver trauma and relative risk factors for mortality: A population-based study. Journal of the Chinese Medical Association, 76(10), 576–582.https://doi.org/10.1016/j.jcma.2013.06.0 04

[19] Chou, S., Rau, C., Su, W., Tsai, C., Hsu, S., & Hsieh, C. (2023). The Association of Albumin-Bilirubin (ALBI) Grade with Mortality Risk in Trauma Patients with Liver Injuries. Risk Management and Healthcare Policy, 16, 279–286. https://doi.org/10.2147/RMHP.S397210

[20] Corrigan, F., Mander, K. A., Leonard, A. V, & Vink, R. (2016). Neurogenic inflammation after traumatic brain injury and its potentiation of classical inflammation. Journal of Neuroinflammation, 13(264), 1–12. https://doi.org/10.1186/s12974-016-0738-9

[21] Duchesne, J. C., Tatum, D., Jones, G., Davis, B., Robledo, R., Demoya, M., Keeffe, T. O., Ferrada, P., Jacome, T., Schroll, R., Wlodarczyk, J., Prakash, P., Smith, B., Inaba, K., Khor, D., Duke, M., Khan, M., & Orleans, N. (2017). Multi-institutional analysis of neutrophil-to-lymphocyte ratio (NLR) in patients with severe hemorrhage: A new mortality predictor value. J Trauma Acute Care Surg, 83(5), 888–893. https://doi.org/10.1097/TA.00000000000016 83

[22] El-menyar, A., Mekkodathil, A., Al-ansari, A., Asim, M., Elmenyar, E., Rizoli, S., & Al-thani, H. (2022). Platelet-Lymphocyte and Neutrophil-Lymphocyte Ratio for Prediction of Hospital Outcomes in Patients with Abdominal Trauma. Hindawi BioMed Research International, 2022, 1–11. https://doi.org/10.1155/2022/5374419 Research

[23] Elbaih, A., Ali, M., Abozaid, A., Saady, B., & Farrag, S. (2016). Role of elevated liver transaminase enzymes in diagnosis of liver injury in cases after abdominal trauma. International Surgery Journal, 3(3), 1184–1192. https://doi.org/10.18203/2349-2902.isj20162704

[24] Faria, S. S., César, P., Jr, F., José, M., Silva, B., Lima, V. C., Fontes, W., Freitas-junior, R., Eterovic, A. K., & Forget, P. (2016). The neutrophil-to-lymphocyte ratio: a narrative review. Ecancer, 10(702), 1–12. https://doi.org/10.3332/ecancer.2016.702

[25] Federico Coccolini, Coimbra, R., Ordonez, C., Kluger, Y., Vega, F., & Moore, E. E. (2020). Liver Trauma: WSES 2020 Guidelines. World Journal of Emergency Surgery, 57(4), 57–67. https://doi.org/10.2298/ACI1004057K

[26] Harris, E. H. (2005). Elevated Liver Function Tests in Type 2 Diabetes. 23(3), 115–119.

[27] Hoye, R. C., Bennett, S. H., Glenn, W., & Gorschboth, C. (2015). Fluid Volume and Albumin Kinetics Occurring with Major. The Journal of the American Medical Association, 222(10), 1255–1261. www.dovepress.com

[28] Ibrahim, F., & Abdelgalel, E. F. (2018). Postoperative outcome in major abdominal trauma: is the treatment of hypoalbuminemia beneficial? Ain-Shams Journal of Anaesthesiology, 10, 97–102. https://doi.org/10.4103/1687-7934.238472

[29] Jyothiprakasan, V. K., Madhusudhan, C., & Reddy, C. S. (2019). Study of blunt trauma abdomen involving liver injuries based on grade of injury, management: a single centre study. International Surgery Journal, 6(3), 793. https://doi.org/10.18203/2349-2902.isj20190470

[30] Karjosukarso, A. S., Wiargitha, I. K., & Bagus Mahadewa, T. G. (2019). Validitas diagnostik Blunt Abdominal Trauma Scoring System (BATSS) pada trauma tumpul abdomen di RSUP Sanglah Denpasar, Bali. Medicina, 50(2), 377–380.https://doi.org/10.15562/medicina.v50i1.181

[31] Koyama, T., Hamada, H., Nishida, M., Naess, P. A., & Gaarder, C. (2016). Defining the optimal cut - off values for liver enzymes in diagnosing blunt liver injury. BMC Research Notes, 9(41), 1–6. https://doi.org/10.1186/s13104-016-1863-3

[32] Kremer, H., Baron-Menguy, CélineTesse, A., Gallois, Y., Mercat, A., Henrion, Daniel Andriantsitohaina, R., Asfar, P., & Meziani, F. (2013). Human serum albumin improves endothelial dysfunction and survival during experimental endotoxemia: Concentration-dependent properties. Crtitical Care Medicine, 39(6), 1414–1422. https://doi.org/DOI 10.1097/CCM.0b013e318211ff6

[33] Lang, M., Dahan, I., Ho, V., & Kapoor, B. (2018). Management of Hepatic Trauma: An Update. Digestive Disease Interventions, 02(02), 159–171.https://doi.org/10.1055/s-0038-1656530

[34] Larsen, M. T., Kuhlmann, M., Hvam, M. L., & Howard, K. A. (2016). Albumin-based drug delivery: harnessing nature to cure disease. Molecular and Cellular Therapies, 4(1), 1–12. https://doi.org/10.1186/s40591-016-0048-8

[35] Levitt, D. G., & Levitt, M. D. (2016). Human serum albumin homeostasis: a new look at the roles of synthesis, catabolism, renal and gastrointestinal excretion, and the clinical value of serum albumin measurements. International Journal of General Medicine, 9, 229–255. www.dovepress.com

[36] Luo, H., Fu, Y., You, C., Liu, C., & Xu, F. (2019). Comparison of admission serum albumin and hemoglobin as predictors of outcome in children with moderate to severe traumatic brain injury. Medicine, 98(44), 1–3.

[37] Moujaess, E., Fakhoury, M., Assi, T., Elias, H., Karak, F. El, Ghosn, M., & Kattan, J. (2017). Critical Reviews in Oncology / Hematology The Therapeutic use of human albumin in cancer patients' management. Critical Reviews in Oncology / Hematology, 120(December 2016), 203–209. https://doi.org/10.1016/j.critrevonc.2017.11.008

[38] Mulyadi, R., Sidipratomo, P., Suroyo, I., Pandelaki, J., Matondang, S., Wicaksono, K. P., & Ramandika, H. (2020). The Role of Endovascular Intervention In Post Liver Hemorrhagic Blunt Trauma. The Indonesian Journal of Gastroenterology, Hepatology, and Digestive Endoscopy, 21(1), 59. https://doi.org/10.24871/211202059-63

[39] Nafees, M., Ditta, A., & Jafferi, G. (2010). Clinical Significance of Elevated Serum Aminotransferases Levels in Asymptomatic Individuals with Hepatitis C Infection. Annals, 16(3), 174–178.

[40] Noyola-Villalobos, H. F., Loera-Torres, M. A., Jiménez-Chavarría, E., Núñez-Cantú, O., García-Núñez, L. M., & Arcaute-Velázquez, F. F. (2016). Non-surgical management after blunt traumatic liver injuries: A review article. Cirugía y Cirujanos (English Edition), 84(3), 263–266. https://doi.org/10.1016/j.circen.2016.04.006

[41] Ogura, T., Lefor, A. T., Nakano, M., Izawa, Y., & Morita, H. (2015). Nonoperative management of hemodynamically unstable abdominal trauma patients with angioembolization and resuscitative endovascular balloon occlusion of the aorta. Journal of Trauma and Acute Care Surgery, 78(1), 132–135.

[42] Peysha, J., & Ferrada, P. (2017). Operative and Nonoperative Management of Blunt Liver Injuries. Current Trauma Reports, 3(1), 38–42. https://doi.org/10.1007/s40719-017-0077-z

[43] Pratt, D. S., & Kaplan, M. M. (2000). E VALUATION OF A BNORMAL A SYMPTOMATIC P ATIENTS. The New England Journal of Medicine Primary, 342, 1266–1272.

[44] Quinlan, G. J., Martin, G. S., & Evans, T. W. (2005). Albumin: Biochemical. Hepatology, 41(6), 1211–1219. https://doi.org/10.1002/hep.20720

[45] Quinlan, G. J., Mumby, S., Martin, G. S., Bernard, G. R., Gutteridge, J. M. C., & Evans, T. W. (2004). Albumin influences total plasma antioxidant capacity favorably in patients with acute lung injury*. Critical Care Medicine, 32(3), 755–759. https://doi.org/10.1097/01.CCM.0000114574.18641.5D

[46] Rhee, D. Y., Park, S. H., & Choi, H. J. (2013). The Value of Neutrophil-Lymphocyte Count Ratio for Disease Severity in Nursing Home Acquired Pneumonia Patients. 17(4), 213–218.

[47] Robinson, D., & Whitehead, T. P. (1989). Effect of body mass and other factors on serum liver enzyme levels in men attending for well population screening. Annals of Clinical Biochemistry, 26(5), 393–400. https://doi.org/10.1177/000456328902600503

[48] Samak, A., Abdeldayem, H., Osman, M., & Taha, M. (2020). Grade-related Liver injury management and its outcome. Al-Azhar International Medical Journal, 0(0), 0–0. https://doi.org/10.21608/aimj.2020.33761.1262

[49] Sastroasmoro, S., & Ismael, S. (2014). Dasar-Dasar Metodologi Penelitian Klinis (Ed 5). Sagung Seto.

[50] Shrestha, A., Neupane, H. C., Tamrakar, K. K., Bhattarai, A., & Katwal, G. (2021). Role of liver enzymes in patients with blunt abdominal trauma to diagnose liver injury. International Journal of Emergency Medicine, 14(1), 1–8. https://doi.org/10.1186/s12245-021-00332-1

[51] Slotta, J. E., Justinger, C., Kollmar, O., Kollmar, C., Schäfer, T., & Schilling, M. K. (2014). Liver injury following blunt abdominal trauma: A new mechanism-driven classification. Surgery Today, 44(2), 241–246. https://doi.org/10.1007/s00595-013-0515-7

[52] Soulaiman, S. E., Dopa, D., Raad, A. T., Hasan, W., Ibrahim, N., Hasan, A., Sulaiman, H. A., & Darwich, M. (2020). Cohort retrospective study: the neutrophil to lymphocyte ratio as an independent predictor of outcomes at the presentation of the multi-trauma patient. International Journal of Emergency Medicine, 13(5), 1–5. https://doi.org/https://doi.org/10.1186/s12245-020-0266-3

[53] Sudiartha, I. P. G., Wiargitha, I. K., & Mahadewa, T. G. B. (2020). Perbedaan nilai Neutrophil Lymphocyte Ratio (NLR) terhadap pemeriksaan kultur darah dalam mendiagnosis sepsis pada pasien peritonitis di RSUP Sanglah, Bali, Indonesia. Intisari Sains Medis, 11(1), 165. https://doi.org/10.15562/ism.v11i1.571

[54] Taghavi, S., & Askari, R. (2021). Liver Trauma. In NCBI Bookshelf. A service of the National Library of Medicine, National Institutes of Health (pp. 1–6).

[55] Templeton, A. J., Mcnamara, M. G., Šeruga, B., Vera-badillo, F. E., Aneja, P., Ocaña, A., Leibowitz-amit, R., Sonpavde, G., Knox, J. J., Tran, B., & Ian, F. (2014). Prognostic Role of Neutrophil-to-Lymphocyte Ratio in Solid Tumors : A Systematic Review and Meta-Analysis. J Natl Cancer Inst, 106(6), 1–11. https://doi.org/10.1093/jnci/dju124

[56] Tian, Z., Liu, H., Su, X., Fang, Z., Dong, Z., Yu, C., & Luo, K. (2012). Role of elevated liver transaminase levels in the diagnosis of liver injury after blunt abdominal trauma. Experimental and Therapeutic Medicine, 4(2), 255–260. https://doi.org/10.3892/etm.2012.575

[57] Tufoni, M., Zaccherini, G., Caraceni, P., & Bernardi, M. (2020). Albumin: Indications in chronic liver disease. United European Gastroenterology Journal, 0(0), 1–8. https://doi.org/10.1177/2050640620910339

[58] University Hospital Consortium. (2010). Guidelines for Use of Albumin. Archives of Internal Medicine, 155, 1–5.

[59] Uribe-querol, E., & Rosales, C. (2015). Neutrophils in Cancer: Two Sides of the Same Coin. Journal of Immunology Research Correlates Hindawi, 2015, 1–25.

[60] Washington, I. M., & Van Hoosier, G. (2012). Clinical Biochemistry and Hematology. In the Laboratory Rabbit, Guinea Pig, Hamster, and Other Rodents. https://doi.org/10.1016/B978-0-12-380920-9.00003-1

[61] Zachariah, S. K., Paul, V., Mathews, K. S., Gopinath, J., M., C. T., & Rajeeve, S. (2018). Hepatic transaminases as predictors of liver injury in abdominal trauma. International Surgery Journal, 5(1), 181. https://doi.org/10.18203/2349-2902.isj20175891

[62] Zhao, D. W., Tian, M., Zhang, L. T., Li, T., Bi, J., He, J. Y., & Zhang, Y. Y. (2017). Effectiveness of contrast-enhanced ultrasound and serum liver enzyme measurement in detection and classification of blunt liver trauma. Journal of International Medical Research, 45(1), 170–181.https://doi.org/10.1177/0300060516678525