Original Article DOI: 10.22114/ajem.v0i0.516

Prognostic Value of Routine Biochemistry Profile of Liver Transplant Patients Admitted to the Emergency Department with a Suspected Infection

Ali Gur[1]*, Adem Kose[2], Hakan Oguzturk[3]

1. Department of Emergency Medicine, School of Medicine, Ataturk University, Erzurum, Turkey.
2. Department of Infectious Diseases, School of Medicine, Inonu University, Malatya, Turkey.
3. Department of Emergency Medicine, School of Medicine, Inonu University, Malatya, Turkey.

***Corresponding author:** Ali Gur; **Email:** doktoraligur@gmail.com

Published online: 2020-09-21

Abstract

Introduction: Since patients who have undergone liver transplantation should take immunosuppressants for life, the prevalence of systemic infections after this procedure is very high. These infections are associated with increased mortality and morbidity.

Objective: This study aimed to investigate the prognostic value of routine biochemistry profile and its relationship with mortality in liver transplant patients admitted to the emergency department (ED) with a suspected infection.

Methods: Patients who had undergone liver transplantation were included in the study. The patients were divided into three groups of culture-negative, culture-positive and control. White blood cell (WBC) count, hemoglobin (Hb), platelet (Plt), international normalized ratio (INR), creatinine (Cr), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) values as well as vital sign findings were comparatively evaluated in terms of their ability to show the presence of any infection and their correlation with mortality.

Results: Totally, 142 patients were enrolled and were divided into the following three groups: 41 cases in culture-negative group, 30 cases in culture-positive group, and 71 cases in control group. There was not any significant difference between study groups in terms of age and sex ratio ($p>0.05$). The Hb and Plt values of the culture-positive patients were significantly lower, and their INR was significantly higher compared to those in control group ($p<0.05$). Fever, Hb, Plt, INR, AST and ALT values were factors that had a significant correlation with mortality in patients with an infection whethere culture-positive or culture-negative ones ($p<0.05$).

Conclusions: In patients admitted to the ED with a history of liver transplantation, we recommend the evaluation of vital signs and Hb, PLt, and INR values to determine whether there is an infection or not. We can also state that mortality risk is higher in cases with low Hb and Plt levels and high INR, ALT, and AST values.

Key words: Emergency Department; Infections; Liver Function Tests; Liver Transplantation; Mortality

Cite this article as: Gur A, Kose A, Oguzturk H. Prognostic Value of Routine Biochemistry Profile of Liver Transplant Patients Admitted to the Emergency Department with a Suspected Infection. Front Emerg Med. 2021;5(1):e10.

INTRODUCTION

Liver transplantation is currently the only treatment for end-stage liver failure. However, since patients who have undergone liver transplantation should take immunosuppressants for life, the frequency of systemic infections, which are mainly caused by bacterial agents, is high in them. Infections are most commonly seen in the first month after liver transplantation, and are associated with increased mortality and morbidity. Therefore, it is necessary to identify infections early and determine the treatment approach in a timely manner in people that have received a liver transplant (1, 2). In these cases, since fever and some other parameters may be suppressed due to immunosuppression, diagnosis is extremely difficult and the only way to make a definitive diagnosis is to perform routine culture analyses. Routine biomarkers that show infections, such as neutrophil count, are not always useful in detecting bacterial infections in these patients because they are elevated in those using steroids and immunosuppressants, which may prevent clinicians from detecting bacterial infections (3). It seems that, various parameters should be evaluated for early detection of infections and related mortality risk in liver transplant patients.

This study aimed to investigate the prognostic value of some routine biochemical profiles and their relationship with mortality in liver transplant patients admitted to the emergency department (ED) with a suspected infection.

Methods

Study design and setting

After obtaining the approval of Inonu University Ethics Committee (approval number: 2016/8-6), the study was conducted prospectively. The study included patients with a history of liver transplantation, which were admitted to the ED of Turgut Ozal Medical Center, Malatya-Turkey between July 1, 2016, and June 30, 2017. Patients who were under the age of 18 years, those with a history of trauma, pregnant women, and cases that presented to the hospital within the first three months after liver transplantation were excluded from the study.

Data gathering

The vital signs of the patients on presentation to the ED were recorded and diagnostic tests were requested according to the clinical condition of each patient. Thereafter, necessary diagnostic treatment approaches were determined based on the decision of the in-charge physician. The name, surname, age, sex, chief complaints, vital signs [systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR), and respiratory rate (RR) and skin surface temperature (T), and routine biochemical profile [including white blood cell (WBC) count, hemoglobin (Hb), platelet count (Plt), international normalized ratio (INR), creatinine (Cr), aspartate aminotransferase (AST) and alanine aminotransferase (ALT)] values were recorded in the form prepared. Then, the culture results of these patients were evaluated, and accordingly the patients were divided into the following three groups: culture-negative (Group 1), culture-positive (Group 2), and control (Group 3). The culture-negative group consists of liver transplant patients with signs of infection and laboratory parameters that support infection, but do not reproduce in blood culture. The culture-positive group consists of liver transplant patients with signs of infection and laboratory parameters that support infection and reproduction in blood culture. The Control group consists of patients with liver transplantation who do not have symptoms of infection and do not reproduce in blood culture. The results of the culture and the length of hospital stay were also recorded in the form. All patients were followed up in the emergency clinic and infectious diseases clinic by the same physicians in a multidisciplinary manner until they were discharged or died in the hospital. The death or survival of each patient was also noted. Diagnosis of sepsis was done based on sepsis conference criteria by the European Society of Intensive Care Medicine and The Society of Critical Care Medicine.

Statistical analysis

The analyses were conducted using IBM SPSS v. 20 statistical analysis program. For normal variables, mean, standard deviation, percentage and numbers were reported. Continuous variables were expressed as means (standard deviations) or medians [interquartile range (IQR)] as appropriate. For continuous variables, the assumption of normal distribution was checked using the Shapiro-Wilk W-test when the sample size was <50, and the Kolmogorov-Smirnov test when the sample size was ≥50. In the comparison between two independent groups, independent samples t-test was conducted when the distribution was normal, and Mann-Whitney u test was used when data were not normally distributed. In comparison of more than two independent groups and continuous variables, ANOVA and Kruskal-Wallis tests were employed for data with and without normal distribution, respectively. After ANOVA, post-hoc tests were also performed using Tukey test when the variances were homogeneous and Tamhane's T2 test when they were not homogeneous. Following Kruskal-Wallis analysis, one-way ANOVA (k samples) was used as a post-hoc test. For 2x2 comparisons between categorical variables, Pearson chi-square test was performed if the expected value was >5, a chi-square test incorporating Yates' correction was performed if this value was 3-5, and Fisher's exact test was used if it was <3. For the comparisons larger than 2x2 between the categorical variables, Pearson chi-square test was used when the expected value was >5 and Fisher-Freeman-Halton test was performed when it was <5.

The receiver operating characteristic (ROC) curve analysis was conducted for hemoglobin, fever, platelet, INR, ALT, AST, and duration of hospitalization to determine whether any of these variables could be used for diagnosis of infection. The ROC curve analysis was also utilized to determine the cut-off values. The best cut-off values were calculated using Youden's Index. A model was created between mortality and significant variables. Logistic regression was performed for each variable. Then the final results were specified for significant parameters using Backward Stepwise (Likelihood Ratio) model. The statistical significance level was taken as $p < 0.05$.

RESULTS

This study included 142 patients and they were divided into the following three groups: 41 cases in group 1, 30 cases in group 2, and 71 cases in group 3. Tables 1 and 2 present the demographic and baseline clinical data of the studied patients in details. There was not any significant difference between study groups in terms of age and sex ratio (p>0.05). When the chief complaints of patients in the 3 groups were compared, there was a significant difference between groups 1 and 3, and also groups 2 and 3 (p=0.001).

When the hospitalization status was compared between the groups, there was a significant difference between groups 1 and 3, and also groups 2 and 3 (p=0.001). When mortality was compared,

Table 1: Demographic and clinical data of the studied groups

Variable	Group-1 Culture-Negative (n:41, 28.9%)	Group-2 Culture-Positive (n:30, 21.1%)	Group-3 Control (n:71, 50%)	Test statistics value	P-value	Post Hoc (Group)
	Number (%)					
Sex						
Female	17 (12.0)	9 (6.3)	21 (14.8)	1.823	0.402*	-
Male	24 (16.9)	21 (14.8)	50 (35.2)			
Chief complaints						
Fever	34(23.9)	29 (20.4)	0 (0.0)	114.566	0.001**	1-3; 2-3
Abdominal Pain	13 (9.2)	4 (2.8)	20 (14.1)	3.212	0.201*	-
Pain+	2 (1.4)	0 (0.0)	34 (23.9)	28.816	0.001**	1-3; 2-3
Nausea-Vomiting	15 (10.6)	9 (6.3)	7 (4.9)	12.366	0.002*	1-3; 2-3
Itching	5 (3.5)	1 (0.7)	12 (8.4)	1,7689	0.467**	-
Weakness	8 (5.6)	6 (4.2)	0 (0.0)	18.461	0.001**	1-3; 2-3
Cought-sputum	6 (4.2)	8 (5.6)	0 (0.0)	19.998	0.001**	1-3; 2-3
Dysuria	9 (6.3)	3 (2.1)	0 (0.0)	2.669	0.312*	-
Dyspnoea	6 (4.2)	3 (2.1)	0 (0.0)	14.261	0.001**	1-3; 2-3
Diarrhea	3 (2.1)	2 (1.4)	4 (2.8)	0.15	1**	-
Anorexia	0 (0.0)	0 (0.0)	7 (4.9)	9.278	0.001**	1-3; 2-3
Others++	0 (0.0)	0 (0.0)	7 (4.9)	21.724	0.001**	1-3; 2-3
Used immunosuppressant						
Tacrolimus	26 (18.3)	20 (14.1)	56 (39.5)	3.571	0.168*	-
Everolimus	6 (4.2)	3 (2.2)	5 (3.5)	1.781	0.408**	-
Tacrolimus +Everolimus	9 (6.3)	7 (4.9)	7 (4.9)	3.832	0.127*	-
Cyclosporine	0 (0.0)	0 (0.0)	3 (2.2)	1.862	0.311**	-
Transplant Reasons						
Hepatitis B	21 (14.8)	16 (11.3)	39 (27.4)	0.398	0.819*	-
Cryptogenic	1 (0.7)	5 (3.5)	6 (4.2)	4.31	0.113**	-
HBV+HDV	1 (0.7)	3 (2.2)	6 (4.2)	2.01	0.461**	-
Toxic hepatitis	3 (2.1)	0 (0.0)	4 (2.8)	1.932	0.406**	-
Alcoholic cirrhosis	3 (2.1)	0 (0.0)	3 (2.1)	1.959	0.404**	-
Primary Biliary cirrhosis	0 (0.0)	2 (1.4)	4 (2.8)	2.690	0.292**	-
Hepatocellular cancer	5 (3.5)	0 (0.0)	2 (1.4)	5.364	0.052**	-
Hepatitis D	3 (2.1)	1 (0.7)	1 (0.7)	2.632	0.178**	-
Hepatitis C	2 (1.4)	1 (0.7)	2 (1.4)	0.651	0.843**	-
Crohn's disease	1 (0.7)	2 (1.4)	0 (0.0)	4.191	0.070**	-
Others+++	1 (0.7)	0 (0.0)	4 (2.8)	1.507	0.503**	-
Hospitalization						
Hospitalized	32 (22.6)	29 (19.0)	16 (11.3)	29.872	0.001**	1-3; 2-3
Discharged	9 (6.3)	1 (0.7)	55 (38.7)			
Mortality						
Live	39 (27.5)	22 (15.5)	71 (50)	19.031	0.001**	1-2; 2-3
Dead	2 (1.4)	8 (5.6)	0 (0.0)			

Pain+: Headache, flank pain, body pain, chest pain, extremity pain, joint pain.
Others++: Any non-infection symptoms.
Others+++: Portal vein thrombus, Wilson disease, Budd- Chiari, Lymphoma.
P*: Pearson chi-square
P**: Fisher-Freeman-Halton.
HBV: Hepatitis B virus; HDV: Hepatitis D virus.

Table 2: Other demographic and clinical data of the studied groups

Variable	Group-1 (n:41)	Group-2 (n:30)	Group-3 (n:71)	Test statistics value	P-value	Post Hoc (Group)
Age	48 (16)+	44 (22)+	44 (18)+	2.416	0.299*	-
Vital Signs						
Systolic blood pressure (mmHg)	124±20++	117±23++	126±15++	10.412	**0.027****	2-3
Diastolic blood pressure (mmHg)	77±9++	74±11++	83±6++	17.975	**0.001****	1-3; 2-3
Pulse rate (beat/ minute)	86±17++	90±27++	78±9++	18.673	**0.001****	1-3; 2-3
Respiratory rate (/minute)	20±2++	21±3++	19±2++	10.900	**0.009****	2-3
Fever (°C)	37.0±0.7++	37.7±0.9++	36.4±0.2++	56.140	**0.001****	1-3; 2-3
Laboratory Results						
WBC(10^3/M)	7.4 (4.8)+	6.4 (7.1)+	6.9 (2.9)+	0.671	0.067*	-
Hemoglobin (g/dL)	11.2 (2.9)+	9.7 (2.5)+	13 (2.7)+	41.088	**0.001***	1-3; 2-3
Platelet (10^3/ML)	191 (89)+	93.5(98.7)+	174 (86)+	28.052	**0.001***	1-3; 2-3
INR	1.1 (0.3)+	1.3 (0.6)+	1 (0.1)+	42.741	**0.001***	1-3; 2-3; 1-2
Creatinine(mg/dL)	0.8 (0.3)+	0.7 (0.5)+	0.8 (0.2)+	0.155	0.925*	-
ALT (U/L)	44 (57)+	64 (133)+	55 (68)+	1.240	0.538*	-
AST (U/L)	45 (45)+	50 (196)+	42 (44)+	3.692	0.157*	-
Duration of hospitalization (day)	8 (9)+	19 (19)+	0 (0)+	64.937	**0.001***	1-3; 2-3; 1-2

p*: Kruskall-Wallis Test p**: One-way ANOVA

Value +: Median- IQR

Value ++: Mean±Standart Deviation

WBC: white blood cells; INR: international normalized ratio; ALT: alanine aminotransferase; AST: aspartate aminotransferase.

Table 3: The sensitivity and specificity of the hemoglobin, fever, platelet count, international normalized ratio (INR), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and duration of hospitalization in prediction of presence of an infection

Variable	Area Under the Curve (ROC)					
	Area ± Std. Error	95% CI for Area Lower - Upper	Cut-off	Sensitivity (%)	Specificity (%)	p
Hemoglobin	0.197±0.068	0.064-0.330	10.150	75	80	0.001
Fever	0.701±0.077	0.550-0.852	36.6	80	63	0.035
Platelet count	0.239±0.088	0.068-0.411	144.5	67	90	0.006
INR	0.844±0.047	0.751-0.936	1.09	100	53	0.000
ALT	0.701±0.105	0.496-0.906	157	90	50	0.035
AST	0.795±0.076	0.645-0.944	198	95	55	0.002
Duration of hospitalization	0.789±0.051	0.689-0.888	9.5	70	50	0.002

INR: international normalized ratio; ALT: alanine aminotransferase; AST: aspartate aminotransferase; Std: standard; CI: confidence interval.

there was a significant difference between groups 1 and 2, and also groups 2 and 3 (p=0.001). When the length of hospital stay was compared, a significant difference was observed between the all study groups (p=0.005) and the longest duration of hospital stay belonged to the culture positive group. When the vital signs of the groups were compared, there was a significant difference between groups 2 and 3 (p=0.005). The mean DBP, PR and T were significantly different between groups 1 and 3 and groups 2 and 3 (p=0.000). In terms of the mean RR, there was a significant difference between groups 2 and 3 (p=0.004). There was no significant difference between the study groups in relation to WBC count, Cr, ALT and AST values (p>0.05). However, the median Hb and Plt count values were significantly different between groups 1 and 3, and also groups 2 and 3 (p=0.000). The median INR value was significantly different between all study groups (p=0.000).

The area under the ROC curve (AUC) and statistic values of each study variable with a 95% confidence interval are specified in table 3 to show which ones indicate the risk of presence of an infection. Based on the findings, Hb lower than 10.1 g/dL (p=0.001), T over 36.6°C (p=0.035), Plt lower than 144.5 10^3/ML (p=0.006), INR higher than 1.09 (p=0.000), ALT higher than 157 U/L (p=0.035), AST higher than 198 U/L (p=0.002), and length of hospital stay higher than 9.5 days (p=0.002) are associated with a higher risk of presence of infection. Figure 1 presents the sensitivity and specificity diagram of Hb, T, Plt, INR, ALT, and AST values and length of hospital stay in prediction of patients' survival.

Table 4 shows the comparison of vital signs and laboratory parameters between the patients who died and those who survived. No significant difference was found in relation to SBP, DBP, PR, and RR (p>0.05). But the body temperature of the

Table 4: Comparison of the vital signs and laboratory parameters between the patients who died and those who survived

Variable	Survived (n:132)	Died (n:10)	P-value
Vital Signs			
Systolic blood pressure (mmHg)	125±18++	117±17++	0.182**
Diastolic blood pressure (mmHg)	79±9++	76±10++	0.269**
Pulse rate (beat/ minute)	83±17++	76±27++	0.282**
Respiratory rate (/minute)	20±2++	20±3++	0.881**
Fever (˚C)	36.8±0.8++	37.2±0.8++	**0.048****
Laboratory Results			
WBC(10^3/M)	6.9 (3.3)+	8.5 (8.6)+	0.222*
Hemoglobin (g/dL)	12.2 (3.5)+	9.4 (3.1)+	**0.001***
Platelet (10^3/ML)	172 (93.2)+	102 (72.2)+	**0.006***
INR	1.0 (0.2)+	1.4 (0.5)+	**0.000***
Creatinine (mg/dL)	0.8 (0.3)+	1.1 (2.1)+	0.317*
ALT (U/L)	52 (65)+	161 (208)+	**0.035***
AST (U/L)	42.5 (43)+	228 (630)+	**0.002***
Duration of hospitalization (day)	0 (13)+	15 (12)+	**0.001***

p*: Mann Whitney U test, p**: Student T test
Value +: Median- IQR
Value ++: Mean±Standart Deviation
WBC: white blood cells; INR: international normalized ratio; ALT: alanine aminotransferase; AST: aspartate aminotransferase.

Table 5: Logistic Regression in prediction of mortality in studied patients

Variable		Exp (B)	95% CI for EXP(B)		P-value
			Lower	Upper	
Step 1	**Fever**	1.065	0.301	3.775	0.922
	Hemoglobin	0.586	0.344	1.000	0.050
	Platelet	1.001	0.991	1.011	0.893
	INR	1.694	0.420	6.825	0.459
	ALT	0.982	0.966	0.999	0.034
	AST	1.015	1.004	1.026	0.007
	Hospitalization	0.995	0.948	1.044	0.839
Step 2	**Hemoglobin**	0.591	0.380	0.919	0.020
	ALT	0.983	0.968	0.997	0.021
	AST	1.015	1.005	1.025	0.004

INR: international normalized ratio; ALT: alanine aminotransferase; AST: aspartate aminotransferase; CI: confidence interval; Exp(B): Exponentiation of the B coefficient.

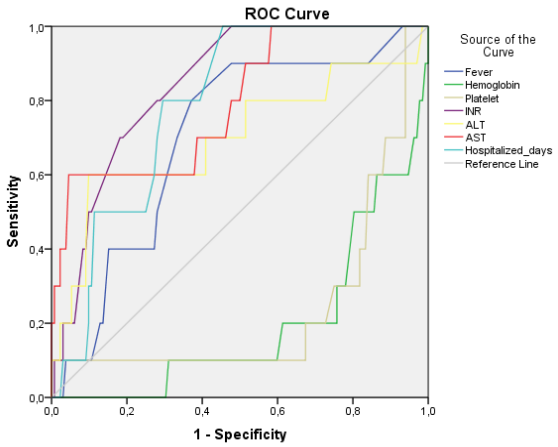

Figure 1: The sensitivity and specificity of the hemoglobin, fever, platelet, international normalized ratio (INR), alanine aminotransferase (ALT), aspartate aminotransferase (AST), and duration of hospitalization in prediction of patients' survival

two groups significantly differed (p=0.048). The median of Hb, Plt, INR, ALT and AST values was significantly different between the two groups (p<0.05). A significant difference was also observed in the length of hospital stay between the patients who died and those who survived (p =0.001).

Table 5 shows logistic regression model in prediction of mortality in studied patients. The evaluations showed that Hb, ALT and AST levels were associated with an increased risk of mortality (p=0.020, p=0.021, p=0.004). It means, when Hb value had decreased, or on the other hand, AST and Alt had increased, mortality was higher.

Discussion

In this study, we investigated whether WBC count, Hb, INR, Plt, Cr, AST, and ALT values were associated with the presence of infection in patients with liver transplants and whether they could predict mortality in liver transplant patients

with suspected infections; and we found that beside vital signs, the values of Hb, Plt, and INR should be evaluated to determine whether there is an infection or not; and also Hb lower than 10.1 g/dL, Plt count lower than 144.5 10^3/ML, INR higher than 1.09, ALT higher than 157 U/L, and AST higher than 198 U/L were associated with a higher risk of mortality.

In clinical practice, the possibility of an infection should be considered in the presence of fever/hypothermia, unexplained tachycardia or tachypnea, signs of peripheral vasodilation, unexplained shock, and deterioration of mental.

state. Other indications causing suspicion of infections include leukocytosis or leukopenia, unexplained lactic acidosis, unexplained changes in renal or hepatic functions, thrombocytopenia or diffuse intravascular coagulation, increased oxygen consumption, and low systemic vascular resistance/increased cardiac output (4). Anemia may be seen in bacterial and viral infections, and thrombocytopenia may also be present in infections due to the suppression of hematopoiesis (5). In a study conducted by Gur et al., SBP, DBP, PR, RR, and body temperature were evaluated of liver transplantation patients with suspicion of infection. In infection group, SBP was 121±22 mmHg, DBP was 76±11 mmHg, PR was 88±23/min, RR 20±3/min, T was 36.8±0.9 ˚C and in control group SBP was 128±14 mmHg, DBP was 82±7 mmHg, PR was 78±9/min, RR 19±2/min, T was 35.9±0.2 ˚C detected. A significant difference was found between the liver transplant cases with and without infections in terms of SBP, DBP, PR, RR, and body temperature in the previous study ($p<0.005$). (6). In current study, in agreement with the literature, SBP, DBP, PR, RR, body temperature, Hb level, thrombocytopenia, and INR significantly correlated between culture-positive group and control group ($p<0.05$). DBP, PR, body temperature, Hb level, thrombocytopenia, and INR significantly correlated between culture-negative group and control group ($p<0.05$). Cr, ALT and AST values did not show a significant correlation between all groups. However, there was also a significant difference between the Hb level, INR, and platelet count values of the culture-positive and culture-negative patient groups.

In a study conducted by Uzan et al., the mean WBC count of liver transplant cases presenting with infection and diagnosed sepsis was found to be 11.74 (10^3/M), and their mean body temperature was 38.5 °C (7). But, in most other studies, the leukocyte values in liver transplant patients were reported to be non-significant in revealing the presence of infections (6, 8, 9). Likewise, in our study, the median of WBC count had no significant difference between the 3 studied groups; But, the median of body temperature had significant difference between the 3 studied groups. It is likely that, in patients who had undergone liver transplantation, WBC count had not significantly changed in the presence of infection but fever presented as a parameter that significantly correlated with infection. In a study including 61 patients with suspected sepsis, Pettila et al. evaluated the changes in the number of leukocytes in treated patients. While treatment resulted in a significant improvement in the number of leukocytes in the patients that survived, an increase in the number of leukocytes was observed in those who died (10). In our study, there was no significant difference between the mortality and surviving groups regarding elevation of WBC count. Unlike exiting literature, we found that increased WBC count did not have any correlation with the mortality of patients who had undergone liver transplantation.

Hb values at the time of presentation were previously reported to be associated with the mortality of patients (11). In the current study, among the liver transplant cases with infections, those with reduced Hb values had a higher rate of mortality, which is consistent with the literature.

When it comes to Plt count, in a study conducted on patients that underwent cardiopulmonary bypass surgery, it was reported that thrombocytopenia was associated with postoperative mortality (12). The relationship between thrombocytopenia and mortality was also indicated by Muhammed et al., who evaluated myopathy cases presenting with infections (13). Similarly, in the current study, we observed that thrombocytopenia was associated with mortality in patients who had received a liver transplant. In the literature, when the relationship of the INR values with mortality was investigated, it was found that they were associated with a higher mortality risk (14). In the current study, a significant difference was observed between the INR values of the patients that died and those who survived. In other words, there was a significant relationship between INR and mortality.

It has been suggested that one of the causes of non-surgical mortality in liver transplant patients is a high serum Cr level (15). In a study conducted on patients having undergone a septic shock, it was reported that high Cr and hypotension were associated with an increased risk of mortality (16). In our study, there was no significant difference between the Cr values of the liver transplant cases

that died of an infection and those who survived. Therefore, we may state that the Cr values of patients who have undergone liver transplantation do not primarily affect the risk of mortality in the presence of an infection, although needs more proofs. In infections that cause the necrosis of liver cells, AST and ALT values are elevated (17). In a study conducted in Japan, AST and ALT values of the patients with liver disease were found to have an association with mortality when compared with individuals without liver disease (18). Based on our findings, we conclude that higher AST and ALT values are associated with mortality in liver transplant patients developing an infection. Some studies reported that hospital stay longer than 14 days was associated with mortality, while others suggested that the length of hospital stay was not related to mortality (19, 20). In the current study, it was seen that as the length of hospital stay increased, the mortality of the patients also increased. Thus, it can be stated that the duration of hospital stay alone does not affect mortality but it is one of the parameters correlating with mortality.

Limitations

It was a single-center study. Hospital-induced deaths may have affected the results of this study. The presence of viral infection could not be investigated in culture-negative patients.

Conclusions

In patients admitted to the ED with a history of liver transplantation, we recommend the evaluation of vital signs and Hb, PLt, and INR values to determine whether there is an infection or not. We can state that mortality risk is higher in cases with low hemoglobin and platelet levels and high INR, ALT, and AST values.

Acknowledgements

The authors thanks to Kamber Kasali from University of Ataturk for Statistical analysis.

Authors' contribution

AG contributed to writing manuscript. AG and HO contributed to data collection. AG and AK contributed to data interpretation. AG and AK contributed to study design. Final approval was given by AG, HO and AK.

Conflict of interest

None declared.

Funding

None declared.

References

1. Moreno A, Cervera C, Gavalda J, Rovira M, De La Cámara R, Jarque I, et al. Bloodstream infections among transplant recipients: results of a Nationwide Surveillance in Spain 1. Am J Transplant. 2007;7(11):2579-86.

2. Chong AS, Alegre M-L. The impact of infection and tissue damage in solid-organ transplantation. Nat Rev Immunol. 2012;12(6):459-71.

3. Cooper D, Sharples L, Cornelissen J, Wallwork J, Alexander G, editors. Comparison between procalcitonin, serum amyloid A, and C-reactive protein as markers of serious bacterial and fungal infections after solid organ transplantation. Transplant Proc. 2001;33(1-2):1808-10.

4. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The third international consensus definitions for sepsis and septic shock (Sepsis-3). JAMA. 2016;315(8):801-10.

5. Hatipoglu H, Erkal S, Turkmen S, Engerek N, Kurt K, Siraneci R. Laboratory findings in the diagnosis of infectious diseases. JOPP Derg. 2011;3(1):5-11.

6. Gür A, Oguzturk H, Köse A, Turtay MG, Ersan V, BAYINDIR Y, et al. Prognostic value of procalcitonin, CRP, serum amyloid A, lactate and IL-6 markers in liver transplant patients admitted to ED with suspected infection. In Vivo. 2017;31(6):1179-85.

7. Uzzan B, Cohen R, Nicolas P, Cucherat M, Perret G-Y. Procalcitonin as a diagnostic test for sepsis in critically ill adults and after surgery or trauma: a systematic review and meta-analysis. Crit Care Med. 2006;34(7):1996-2003.

8. Cetinkaya M, Özkan H, Köksal N, Celebi S, Hacımustafaoğlu M. Comparison of serum amyloid A concentrations with those of C-reactive protein and procalcitonin in diagnosis and follow-up of neonatal sepsis in premature infants. J Perinatol. 2009;29(3):225-31.

9. van den Broek MA, Damink SWO, Winkens B, Broelsch CE, Malagó M, Paul A, et al. Procalcitonin as a prognostic marker for infectious complications in liver transplant recipients in an intensive care unit. Liver Transpl. 2010;16(3):402-10.
10. Pettilä V, Hynninen M, Takkunen O, Kuusela P, Valtonen M. Predictive value of procalcitonin and interleukin 6 in critically ill patients with suspected sepsis. Intensive Care Med. 2002;28(9):1220-5.
11. Ghiani A, Sainis A, Sainis G, Neurohr C. Anemia and red blood cell transfusion practice in prolonged mechanically ventilated patients admitted to a specialized weaning center: an observational study. BMC Pulm Med. 2019;19(1):1-9.
12. Griffin BR, Bronsert M, Reece TB, Pal JD, Cleveland JC, Fullerton DA, et al. Thrombocytopenia after cardiopulmonary bypass is associated with increased morbidity and mortality. Ann Thorac Surg. 2020;110(1):50-7.
13. Muhammed H, Gupta L, Lawrence A. Infections Are Leading Cause of In-Hospital Mortality in Indian Patients With Inflammatory Myopathy. J Clin Rheumatol. 2019; (ahead of print).
14. Santas E, Minana G, Gummel J, Farcasan R, Paya A, Heredia R, et al. International Normalized Ratio and Mortality Risk in Acute Heart Failure and Nonvalvular Atrial Fibrillation Patients Receiving Vitamin K Antagonists. Rev Esp Cardiol (Engl Ed). 2019;72(8):616-24.
15. Yaprak O, Guler N, Dayangac M, Demirbas BT, Yuzer Y, Tokat Y. Factors affecting perioperative mortality in right lobe liver transplantation with live donor. Turk J Surg. 2011;27(1):82-5.
16. Sasko B, Butz T, Prull MW, Liebeton J, Christ M, Trappe H-J. Earliest bedside assessment of hemodynamic parameters and cardiac biomarkers: their role as predictors of adverse outcome in patients with septic shock. Int J Med Sci. 2015;12(9):680-8.
17. Ersoy O. Evaluation of Liver Enzyme Height. Ankara Med J. 2012;12(3):129-35.
18. Yuwaki K, Shimazu T, Yamagiwa Y, Inoue M, Goto A, Yamaji T, et al. Association between serum liver enzymes and all-cause mortality: The Japan Public Health Center-based Prospective Study. Liver Int. 2019;39(8):1566-76.
19. Bueno-Cavanillas A, Delgado-Rodríguez M, López-Luque A, Schaffino-Cano S, Gálvez-Vargas R. Influence of nosocomial infection on mortality rate in an intensive care unit. Crit Care Med. 1994;22(1):55-60.
20. Ceylan E, Itil O, Ari G, Ellidokuz H, Ucan ES, Akkoclu A. Factors affecting mortality and morbidity in patients followed up in the internal medicine intensive care unit. Turk Thorac J. 2001;2(1):6-12.