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Comparison of Child-Pugh, MELD, MELD-Na, and ALBI Scores in Predicting In-Hospital Mortality in Patients with HCC

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Abstract

Background & Objectives: Hepatocellular carcinoma (HCC) leads to high morbidity and mortality. Various models have been proposed for predicting the outcome of patients with HCC. We aim to compare the prognostic abilities of Child-Pugh, MELD, MELD-Na, and ALBI scores for predicting in-hospital mortality of HCC. **Methods:** We enrolled patients diagnosed with liver cirrhosis and HCC from May 2017 through May 2018. We further divided eligible patients into hepatitis B virus (HBV), patients without ascites, and patients with ascites subgroups. Areas under the characteristic curves (AUCs) were analyzed. **Results:** A total of 495 patients were included in the study. We collected data on patients at admission. A majority of patients were infected with HBV (91.5%). None of them were complicated with hepatic encephalopathy. Only 14.9% of patients presented with ascites. In the whole population, AUCs with 95% confidence interval (CI) of Child-Pugh, ALBI, MELD, and MELD-Na scores in predicting in-hospital mortality were 0.889 (95% CI: 0.858 - 0.915), 0.849 (95% CI: 0.814 - 0.879), 0.669 (95% CI: 0.626 - 0.711), and 0.721 (95% CI: 0.679 - 0.760), respectively. In the patients without ascites subgroup, Child-Pugh showed better discriminatory ability than ALBI score in predicting in-hospital mortality (P = 0.0002), while there were no significant differences among other comparisons. **Conclusions:** Child-Pugh and ALBI may be useful predictors for predicting in-hospital mortality in whole patients, in patients with HBV infection, and in patients without ascites. In HCC patients with ascites, MELD-Na may be effective for predicting in-hospital mortality.

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Keywords

Hepatocellular Carcinoma, Child-Pugh Score, MELD Score, MELD-Na Score, ALBI Score, In-Hospital Mortality

1. Introduction

Hepatocellular carcinoma (HCC) is the fourth cause of cancer-related mortality all over the globe [1]. HCC is the second leading cause of cancer disability-adjusted life-years (DALYs), which increases the disease burden of patients [2]. Chronic hepatitis B virus (HBV) and hepatitis C infection (HCV) infection are the primary causes of HCC. Approximately 85% - 95% of patients with HCC are in the setting of liver cirrhosis concerning viral hepatitis infection [3]. With an increasing incidence of obesity, diabetes, and metabolic syndrome in developed regions, non-alcoholic steatohepatitis (NASH) has become the predominant risk factor for HCC [4] [5]. Alcohol abuse, aflatoxin B1, and aristolochic acid exposure also contributed to the occurrence of HCC [6] [7] [8]. Chronic viral hepatitis infection may progress to liver cirrhosis or HCC even when they achieve sustained virological response (SVR). Moreover, there is no approved therapy for NASH [9] [10]. Therefore, early identification of high-risk populations is crucial for improving the prognosis and reducing the disease-related mortality and health burden of HCC patients.

The Child-Pugh score, including five variables, total bilirubin, albumin, ascites, hepatic encephalopathy (HE), and international normalized ratio (INR), has been widely used for assessing liver function. However, subjective indicators may reduce its reliability [11]. The model for end-stage liver diseases (MELD), calculated by total bilirubin, creatinine, and INR, has been used for evaluating patients who should undergo liver transplantation in priority, which substantially reduces mortality [12]. Serum sodium (Na) has been reported as an independent predictor associated with liver-related complications and mortality [13] [14]. MELD-Na, incorporating Na into the MELD algorithm, shows more accuracy decreasing waiting list mortality than MELD [15]. It also has been validated in patients with HBV infection, liver cirrhosis, acute-on-chronic hepatitis B liver failure (HBV-AoCLF), HCC, and patients undergoing transjugular intrahepatic portosystemic shunt (TIPS) and liver transplantation [16]-[22]. Albumin-bilirubin score (ALBI), including two objective parameters, albumin and bilirubin, which eliminates the subjective inclination of HE and ascites in Child-Pugh, has been used for assessing the prognosis in patients with HCC, liver cirrhosis, and HBV-AoCLF [23] [24] [25]. Previous studies have compared the accuracy of various invasive tools in evaluating the prognosis of patients with HCC, whereas the results turn out to be different [18] [26] [27]. Our study aims to explore the discriminatory abilities among Child-Pugh, MELD, MELD-Na, and ALBI scores in predicting in-hospital mortality of patients with liver cirrhosis complicated with HCC.

2. Material and Methods

2.1. Patients and Methods

We retrospectively collected patients admitted to Southwest Hospital between May 2017 and May 2018. All patients were diagnosed with liver cirrhosis and HCC based on medical history, imaging, or histopathological examinations. Patients with other malignancies and incomplete laboratory results were excluded. In-hospital mortality was defined as an outcome. STARD reporting guidelines were applied [28].

The following characteristics included etiology, serum biomarkers at admission (red blood count, platelets, total bilirubin, albumin, creatinine, Na, K, Ca, INR, etc.), patients presenting with HE and ascites, and in-hospital death were reviewed. Child-Pugh, MELD, MELD-Na, and ALBI scores were calculated. We further analyzed patients with HBV infection, with or without ascites. This study was approved by the Ethics Committee Board of Southwest Hospital (KY2021009).

Child-Pugh was calculated based on five parameters: total bilirubin, albumin, ascites, HE, and INR. Grade A: 5 - 6 scores; grade B: 7 - 9 scores; grade C: 10 - 15 scores.

MELD [12] = $9.57 \times \log_e$ (creatinine (mg/dL) + $3.78 \times \log_e$ (bilirubin (mg/dL)) + $11.2 \times \log_e$ (INR) + 6.43

MELD-Na [16] = MELD + $1.59 \times (135 - \text{Na (mmol/L)})$

ALBI [23] = $0.66 \times \log10$ (bilirubin (μmol/L)) − $0.085 \times$ (albumin (g/L))

ALBI is classified into three grades: grade 1 ≤ −2.6; grade 2 > −2.6 and ≤ −1.39; grade 3 > −1.39.

2.2. Statistical Analysis

Continuous data were expressed as mean ± standard deviation (SD) and median (range). Categorical data were expressed as frequency (percentage). The analysis was performed by SPSS version 23.0. The predictive abilities of the four scores were calculated using the receiver operating characteristic (ROC) curve analyses. The areas under the ROC curves (AUCs) with 95% confidence intervals (CIs) were compared by the De-long test. The cut-off value, sensitivity, specificity, positive likelihood ratio (LR), and negative LR were also shown. ROC analyses were performed by MedCalc version 11.4.2.0. P-value < 0.05 was considered significantly different.

3. Results

After exclusion, 495 patients with liver cirrhosis suffering HCC were included in the analysis. The baseline characteristics were shown in **Table 1**. The in-hospital mortality was 1.0% (5/495). A total of 439 patients were male sex (88.7%). The majority of patients were infected with HBV (91.5%), followed by alcohol abuse (3.6%). Most patients did not complicate with ascites (85.1%). None of them presented with HE at admission. The mean value of Child-Pugh, ALBI, MELD, and MELD-Na were 5.6 ± 1.2, −2.5 ± 0.6, 5.5 ± 3.6, and −1.4 ± 6.4, respectively.

Table 1. Baseline characteristics.

Variables	Mean ± SD or Frequency (percentage)	Median (Range)
Sex (male/female)	439/56	
Age (years)	53.8 ± 10.6	53.0 (24.0 - 80.0)
Causes of liver diseases, n (%)		
Hepatitis B virus	453 (91.5)	
Hepatitis C virus	7 (1.4)	
Alcohol	18 (3.6)	
Hepatitis B virus + Alcohol	3 (0.6)	
Hepatitis B virus + Hepatitis C virus	1 (0.2)	
Unknown	13 (2.6)	
Vital signs		
Systolic blood pressure (mmHg)	123.6 ± 15.2	122.0 (90.0 - 180.0)
Diastolic blood pressure (mmHg)	78.4 ± 10.8	78.0 (50.0 - 114.0)
Heart rate (b.p.m.)	79.0 ± 13.2	78.0 (50.0 - 123.0)
Laboratory tests		
RBC (10^{*12}/L)	4.4 ± 0.7	4.5 (1.8 - 6.6)
Hb (g/L)	135.8 ± 22.3	140.0 (51.0 - 187.0)
WBC (10^{*12}/L)	5.0 ± 2.2	4.7 (1.1 - 22.9)
PLT (10^{*9}/L)	127.8 ± 75.9	117.0 (6.0 - 552.0)
TBIL (umol/L)	27.6 ± 47.6	18.1 (4.1 - 483.3)
DBIL (umol/L)	10.4 ± 29.6	5.2 (0.8 - 398.2)
IBIL (umol/L)	16.8 ± 22.3	12.3 (0.8 - 398.2)
ALB (g/L)	39.6 ± 5.9	40.2 (21.7 - 54.2)
ALT (U/L)	55.0 ± 74.3	35.2 (3.0 - 893.0)
AST (U/L)	73.3 ± 139.6	39.5 (13.4 - 1810.1)
ALP (U/L)	135.9 ± 108.5	111.0 (24.0 - 1743.0)
GGT (U/L)	115.9 ± 138.9	69.0 (7.0 - 1079.0)
BUN (mmol/L)	5.6 ± 2.0	5.2 (2.2 - 18.4)
CR (umol/L)	72.0 ± 16.1	71.0 (35.1 - 166.2)
K (mmol/L)	4.0 ± 0.4	4.0 (2.8 - 5.8)
Na (mmol/L)	139.4 ± 2.8	139.5 (120.0 - 150.0)
Ca (mmol/L)	2.3 ± 0.2	2.3 (1.8 - 3.1)
PT (second)	12.8 ± 1.7	12.4 (10.0 - 29.1)
APTT (second)	31.5 ± 6.4	30.1 (18.9 - 74.8)
INR	1.1 ± 0.1	1.1 (0.9 - 2.5)
Ascites (No/Mild/Moderate-Severe)	421/51/23	
Hepatic encephalopathy (No/Grade I-II/Grade III-IV)	495/0/0	
Child-Pugh class (A/B/C)	418/69/8	
Child-Pugh score	5.6 ± 1.2	5.0 (5.0 - 11.0)
MELD score	5.5 ± 3.6	5.2 (−3.4 - 25.4)
ALBI grade (1/2/3)	249/220/26	
ALBI score	−2.5 ± 0.6	−2.6 (−3.8 - (−0.2))
MELD-Na score	−1.4 ± 6.4	−2.5 (−20.1 - 43.9)

Abbreviations: ALB, albumin; ALBI, albumin-bilirubin; ALP, alkaline phosphatase; ALT, alanine aminotransferase; APTT, activated partial thromboplastin time; AST, aspartate aminotransferase; BUN, blood urea nitrogen; CR, creatinine; DBIL, direct bilirubin; GGT, gamma-glutamyl transpeptidase; IBIL, indirect bilirubin; INR, international normalized ratio; MELD, model for end-stage liver disease; PLT, platelet; PT, prothrombin time; RBC, red blood count; SD, standard deviation; TBIL, total bilirubin; WBC, white blood count.

As presented in Table 2, Child-Pugh showed a good performance in predicting in-hospital mortality. The AUC of Child-Pugh was 0.889 (95% CI: 0.858 - 0.915, P < 0. 0001), with a sensitivity of 100.00% and specificity of 70.20%. The cut-off value was 5. ALBI was also a good discriminator in evaluating in-hospital mortality. The AUC of ALBI was 0.849 (95% CI: 0.814 - 0.879, P < 0. 0001), with a sensitivity of 100.00% and specificity of 72.45%. The cut-off value was −2.22. The AUCs of MELD and MELD-Na were 0.669 (95% CI: 0.626 - 0.711, P = 0.339) and 0.721 (95% CI: 0.679 - 0.760, P = 0.153), respectively. The cut-off values were 10.74 and 3.59, respectively. However, the prognostic differences among the four scores were not statistically significant.

3.1. Patients with HBV Infection

We analyzed 453 HCC patients with HBV infection. The baseline characteristics were presented in Table S1. Four patients died in the hospital (0.9%). The mean values of Child-Pugh, ALBI, MELD, and MELD-Na were 5.6 ± 1.1, −2.5 ± 0.6, 5.4 ± 3.5, and −1.5 ± 6.0, respectively. The AUCs of Child-Pugh, ALBI, MELD, and MELD-Na were 0.872 (95% CI: 0.838 - 0.901, P < 0.0001), 0.823 (95% CI: 0.785 - 0.857, P < 0.0001), 0.607 (95% CI: 0.560 - 0.652, P = 0.614), and 0.653 (95% CI: 0.607 - 0.696, P = 0.398), respectively. The results of comparisons among Child-Pugh, ALBI, MELD, and MELD-Na were shown in Figure 1. No statistically significant differences were observed among the comparisons of the four scores (All P values > 0.05).

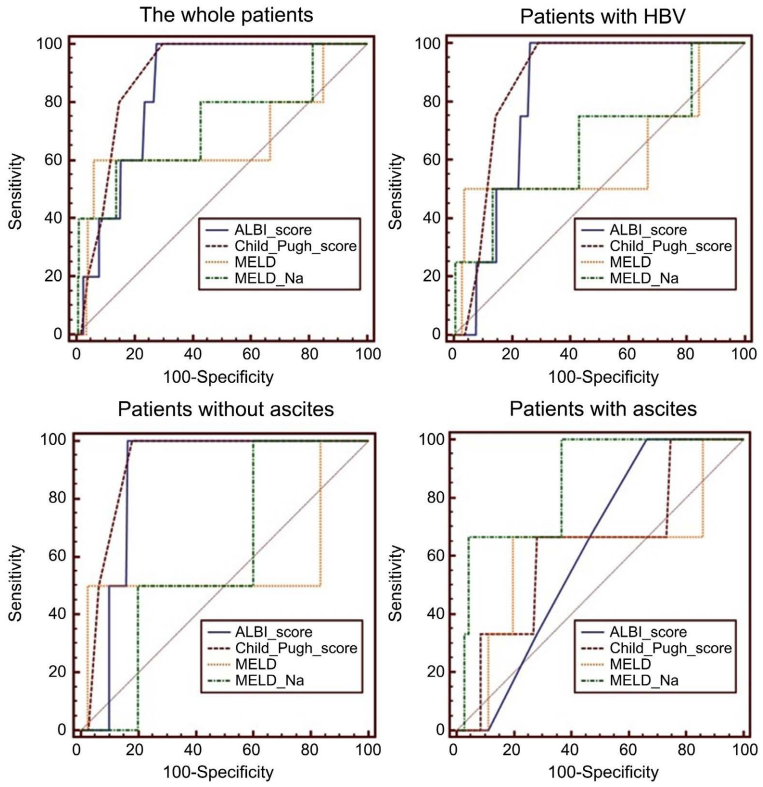

Figure 1. Comparison of four scores.

Table 2. ROC analyses of Child-Pugh, MELD, MELD-Na, and ALBI scores.

Prognostic scores	AUC (95% CI)	Cut-off value	Sensitivity (95%CI)	Specificity (95% CI)	Positive LR	Negative LR	P value
The whole patients							
Child-Pugh score	0.889 (0.858 - 0.915)	5	100.00 (47.8 - 100)	70.20 (65.9 - 74.2)	3.36	0	<0.0001
ALBI score	0.849 (0.814 - 0.879)	−2.22	100.00 (47.8 - 100)	72.45 (68.3 - 76.4)	3.63	0	<0.0001
MELD score	0.669 (0.626 - 0.711)	10.74	60.00 (14.7 - 94.7)	93.88 (91.4 - 95.8)	9.80	0.43	0.3391
MELD-Na score	0.721 (0.679 - 0.760)	3.59	60.00 (14.7 - 94.7)	86.33 (83.0 - 89.2)	4.39	0.46	0.1527
Subgroup—Patients with HBV infection							
Child-Pugh score	0.872 (0.838 - 0.901)	5	100.00 (39.8 - 100)	71.05 (66.6 - 75.2)	3.45	0	<0.0001
ALBI score	0.823 (0.785 - 0.857)	−2.22	100.00 (39.8 - 100)	73.72 (69.4 - 77.7)	3.81	0	<0.0001
MELD score	0.607 (0.560 - 0.652)	11.36	50.00 (6.8 - 93.2)	96.44 (94.3 - 97.9)	14.03	0.52	0.6135
MELD-Na score	0.653 (0.607 - 0.696)	3.59	50.00 (6.8 - 93.2)	86.64 (83.1 - 89.6)	3.74	0.58	0.3982
Subgroup—Patients without ascites							
Child-Pugh score	0.918 (0.887 - 0.942)	5	100.00 (15.8 - 100)	82.10 (78.1 - 85.7)	5.59	0	<0.0001
ALBI score	0.871 (0.835 - 0.901)	−2.16	100.00 (15.8 - 100)	83.77 (79.9 - 87.2)	6.16	0	<0.0001
MELD score	0.570 (0.522 - 0.618)	11.36	50.00 (1.3 - 98.7)	97.61 (95.7 - 98.8)	20.95	0.51	0.8623
MELD-Na score	0.600 (0.552 - 0.647)	−1.59	100.00 (15.8 - 100)	39.86 (35.1 - 44.7)	1.66	0	0.6206
Subgroup—Patients with ascites							
Child-Pugh score	0.622 (0.502 - 0.732)	6	100.00 (29.2 - 100)	33.80 (23.0 - 46.0)	1.51	0	0.2873
ALBI score	0.634 (0.514 - 0.743)	−1.63	66.67 (9.4 - 99.2)	71.83 (59.9 - 81.9)	2.37	0.46	0.4984
MELD score	0.610 (0.490 - 0.722)	10.28	66.67 (9.4 - 99.2)	80.28 (69.1 - 88.8)	3.38	0.42	0.6432
MELD-Na score	0.854 (0.753 - 0.926)	3.59	100.00 (29.2 - 100.0)	63.88 (51.1 - 74.5)	2.73	0	0.0018

Abbreviations: ALBI, albumin-bilirubin; AUC, area under the receiver operating characteristic curve; CI, confidence interval; HBV, hepatitis B virus; LR, likelihood ratio; MELD, model for end-stage liver disease; ROC, receiver operating characteristic.

3.2. Patients Presented without Ascites

To compare the predictive power of the four scores in HCC patients with and without ascites, we did further analysis. In patients without ascites, the in-hospital mortality was 0.5% (2/421). The mean values of Child-Pugh, ALBI, MELD, and MELD-Na scores were 5.3 ± 0.7, −2.6 ± 0.5, 5.1 ± 3.2, and −2.2 ± 5.3, respectively (Table S2). Child-Pugh and ALBI had better discriminatory performance than MELD and MELD-Na in predicting in-hospital mortality in this subgroup. The AUCs of Child-Pugh, ALBI, MELD, and MELD-Na in predicting in-hospital mortality were 0.918 (95% CI: 0.838 - 0.901, P < 0.0001), 0.871 (95% CI: 0.835 - 0.901, P < 0.0001), 0.570 (95% CI: 0.522 - 0.618, P = 0.862), and 0.600 (95% CI: 0.552 - 0.647, P = 0.621), respectively (Table 2). In this subgroup, Child-Pugh showed excellent predictive ability in predicting in-hospital mortality. Furthermore, Child-Pugh was a superior discriminator than ALBI in assessing in-hospital mortality (P = 0.0002). Nevertheless, there were no differences when compared between the other scores (Figure 1).

3.3. Patients Presented with Ascites

A total of 74 patients presented with ascites. In this subgroup, three patients occurred death in hospital (4.1%). Fifty-one patients were complicated with mild ascites at admission (68.9%). The mean values of Child-Pugh, ALBI, MELD, and MELD-Na were 7.6 ± 1.4, −1.9 ± 0.6, 7.8 ± 4.5, and 3.1 ± 9.8, respectively, which were higher than those in other groups (**Table S3**). The AUCs of Child-Pugh, ALBI, MELD, and MELD-Na were 0.622 (95% CI: 0.502 - 0.732, P = 0.287), 0.634 (95% CI: 0.514 - 0.743, P = 0.498), 0.610 (95% CI: 0.490 - 0.722, P = 0.643), and 0.854 (95% CI: 0.753 - 0.926, P = 0.002), respectively (**Table 2**). In this subgroup, MELD-Na was the only significant prognostic score in predicting in-hospital mortality. However, no significant differences were found in the comparisons (**Figure 1**).

4. Discussion

We performed a retrospective study to compare the predictive abilities of Child-Pugh, ALBI, MELD, MELD-Na in predicting in-hospital mortality of patients with HCC. We found that Child-Pugh and ALBI performed better discriminatory abilities than MELD and MELD-Na except for patients with ascites group. In patients without ascites, Child-Pugh provided significantly better prognostic performance than the ALBI score. In patients with ascites, MELD-Na was superior to the other three scores. MELD has the lowest discriminatory ability in predicting in-hospital mortality in all groups. However, there were no statistically significant differences when compared among the four scores in the whole patients, in HBV infection, and in patients with ascites groups. We may explain these results from the following three aspects.

Firstly, most HCC patients in our hospital are not in severe conditions. None of the patients presents with HE. A few patients develop complications like gastrointestinal bleeding, hepatorenal syndrome, or spontaneous bacterial peritonitis. Child-Pugh and ALBI scores mainly focus on evaluating liver function, whereas MELD and MELD-Na consist of parameters evaluating renal function, which may contribute to the superiority of Child-Pugh and ALBI scores.

Secondly, patients with low sodium levels are prone to develop ascites, which may explain why MELD-Na is superior to the other three scores in patients with ascites subgroup.

Thirdly, the majority of patients are infected with HBV, which conforms with the epidemiology in our country. Although new antiviral medications have been used for clinical application, patients who have progressed to liver cirrhosis or do not receive SVR also have the risk of developing HCC.

Barcelona Clinical Liver Cancer (BCLC) staging system is the most widely used system for HCC staging classification, which could guide therapeutic strategies [29]. Patients with very early stage (0) are the candidates for surgery, and patients with early stage (A) are eligible for liver transplantation, local ablation, or percutaneous ethanol injection. Patients with the intermediate stage (B) are

recommended for chemoembolization and patients with advanced stage (C) are eligible for sorafenib. Patients with the terminal stage (D) should receive supportive care [30]. Unfortunately, nearly half of patients are first diagnosed at an advanced stage, which results in poor prognosis due to lack of curative treatment. Therefore, to reduce the mortality of patients with HCC, it is essential for improving risk stratification and discriminating patients with early stages.

Ultrasonography (US) is the primary tool which is recommended for surveillance of HCC, whereas it can be affected by doctors' experience and obesity. AFP is the most commonly used serum biomarker for the diagnosis and surveillance of HCC but with low sensitivity. It has been reported that des-gamma-carboxyprothrombin (DCP) performs superior diagnostic accuracy than AFP regardless of tumor size, population, and etiology [31]. With the combination of DCP or US could improve the reliability of AFP in detecting early-stage HCC [20]. Previous studies have shown that serum GP73 is an independent factor for assessing complications and predicting postoperative outcomes in HCC patients undergoing hepatectomy [32]. The combinations of miR-130b, miR-150, miR-182, miR-215, and miR-96 are excellent for the diagnosis of HCC, with an accuracy of 94.1%. Promising technologies such as liquid biopsies, including circulating tumor DNA (ctDNA) and circulating cell-free DNA (cfDNA), have been testified useful for detection and surveillance of HCC. However, these new serum biomarkers are not recommended for lacking further validation. Therefore, reliable and effective non-invasive prognosticators for risk stratification of HCC are needed for clinical guidance.

There have been many studies comparing the discriminative abilities of various prognostic biomarkers. Zhao *et al.* conducted a retrospective study enrolling patients with HCC after liver resection, which compared the prognostic values between Child-Pugh and ALBI scores in predicting postoperative overall survival. Results showed that ALBI was superior to Child-Pugh [33]. They also performed a retrospective study including HCC patients who received transarterial chemoembolization (TACE), ALBI also performed better prognostic capability than Child-Pugh in predicting survival [34]. Hiraoka *et al.* also revealed ALBI was preferable to Child-Pugh in assessing liver function in HCC patients [35]. To compare with our study, the opposite results may contribute to patient selection and condition. Kim *et al.* have compared the prognostic performances among Child-Pugh, MELD, MELD-Na, and ALBI scores in HCC patients with ascites. MELD-Na could effectively discriminate liver function and mortality, which was consistent with our results [20]. Except for the above-mentioned non-invasive prognostic scores, new models such as platelet-albumin-bilirubin (PALBI), malnutrition, modified Glasgow prognostic score (mGPS), and neutrophil-to-lymphocyte ratio (NLR) have been reported as independent factors in predicting outcomes of HCC [36] [37] [38] [39]. Nonetheless, these prognostic indicators still need to be validated by well-designed trials before applying them to clinical practice.

There are some limitations in our study that should be mentioned. This was a retrospective study; we could not collect complete data; we did not stratify patients with different HCC stages or patients who received different therapies; no patient included in this study presented with HE; this study lacked long-term follow-up.

5. Conclusion

In summary, Child-Pugh and ALBI may be effective predictors for assessing in-hospital mortality in cirrhotic patients complicated with HCC. However, in HCC patients with ascites, MELD-Na may be an alternative indicator for predicting in-hospital mortality. Moreover, new models assessing liver function combined with tumor stages may be more effective for predicting prognosis in HCC patients. Further studies should be strictly designed to explore new prognostic models.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Table S1. Baseline characteristics of patients with HBV infection.

Variables	Mean ± SD or Frequency (percentage)	Median (Range)
Sex (male/female)	401/52	
Age (years)	53.1 ± 10.5	52.0 (24.0 - 77.0)
Vital signs		
Systolic blood pressure (mmHg)	123.3 ± 15.2	122.0 (90.0 - 180.0)
Diastolic blood pressure (mmHg)	78.6 ± 10.8	78.0 (50.0 - 114.0)
Heart rate (b.p.m.)	79.1 ± 13.2	78.0 (50.0 - 123.0)
Laboratory tests		
RBC (10^{*12}/L)	4.5 ± 0.7	4.5 (1.8 - 6.6)
Hb (g/L)	136.7 ± 22.0	141.0 (51.0 - 187.0)
WBC (10^{*12}/L)	5.0 ± 2.2	4.7 (1.1 - 22.9)
PLT (10^{*9}/L)	130.1 ± 77.3	121.0 (6.0 - 552.0)
TBIL (umol/L)	26.3 ± 43.3	18.0 (4.1 - 483.3)
DBIL (umol/L)	9.7 ± 27.2	5.1 (0.8 - 398.2)
IBIL (umol/L)	16.3 ± 21.1	12.3 (0.8 - 314.1)
ALB (g/L)	39.8 ± 5.8	40.3 (21.7 - 54.2)
ALT (U/L)	56.1 ± 76.9	35.5 (3.0 - 893.0)
AST (U/L)	74.4 ± 145.1	39.7 (13.4 - 1810.1)
ALP (U/L)	134.5 ± 112.1	108.0 (24.0 - 1743.0)
GGT (U/L)	111.1 ± 138.4	65.0 (7.0 - 1079.0)
BUN (mmol/L)	5.5 ± 1.9	5.2 (2.2 - 18.4)
CR (umol/L)	71.9 ± 15.9	71.0 (35.1 - 166.2)
K (mmol/L)	4.0 ± 0.4	4.1 (2.9 - 5.8)
Na (mmol/L)	139.4 ± 2.6	139.5 (126.8 - 150.0)
Ca (mmol/L)	2.3 ± 0.1	2.3 (1.8 - 2.9)
PT (second)	12.8 ± 1.7	12.4 (10.0 - 29.1)
APTT (second)	31.3 ± 6.1	30.1 (18.9 - 67.6)
INR	1.1 ± 0.1	1.1 (0.9 - 2.5)
Ascites (No/Mild/Moderate-Severe)	386/48/19	
Hepatic encephalopathy (No/Grade I-II/Grade III-IV)	453/0/0	
Child-Pugh class (A/B/C)	385/62/6	
Child-Pugh score	5.6 ± 1.1	5.0 (5.0 - 11.0)
MELD score	5.4 ± 3.5	5.1 (−3.4 - 25.4)
ALBI grade (1/2/3)	235/196/22	
ALBI score	−2.5 ± 0.6	−2.6 (−3.8 - (−0.2))
MELD-Na score	−1.5 ± 6.0	−2.4 (−20.1 - 38.5)

Abbreviations: ALB, albumin; ALBI, albumin-bilirubin; ALP, alkaline phosphatase; ALT, alanine aminotransferase; APTT, activated partial thromboplastin time; AST, aspartate aminotransferase; BUN, blood urea nitrogen; CR, creatinine; DBIL, direct bilirubin; GGT, gamma-glutamyl transpeptidase; HBV, hepatitis B virus; IBIL, indirect bilirubin; INR, international normalized ratio; MELD, model for end-stage liver disease; PLT, platelet; PT, prothrombin time; RBC, red blood count; SD, standard deviation; TBIL, total bilirubin; WBC, white blood count.

Table S2. ROC analyses of Child-Pugh, MELD, MELD-Na, and ALBI scores.

Variables	Mean ± SD or Frequency (percentage)	Median (Range)
Sex (male/female)	374/47	
Age (years)	53.5 ± 10.6	53.0 (24.0 - 80.0)
Causes of liver diseases, n (%)		
Hepatitis B virus	386 (91.7)	
Hepatitis C virus	6 (1.5)	
Alcohol	15 (3.5)	
Hepatitis B virus + Hepatitis C virus	1 (0.2)	
Unknown	13 (3.1)	
Vital signs		
Systolic blood pressure (mmHg)	124.2 ± 15.1	123.0 (90.0 - 180.0)
Diastolic blood pressure (mmHg)	78.9 ± 10.4	79.0 (52.0 - 114.0)
Heart rate (b.p.m.)	78.1 ± 12.7	77.0 (50.0 - 118.0)
Laboratory tests		
RBC (10^{*12}/L)	4.5 ± 0.6	4.6 (1.8 - 6.6)
Hb (g/L)	139.2 ± 19.6	143.0 (58.0 - 187.0)
WBC (10^{*12}/L)	5.1 ± 2.1	4.7 (1.5 - 22.9)
PLT (10^{*9}/L)	129.4 ± 70.6	122.0 (25.0 - 552.0)
TBIL (umol/L)	23.7 ± 39.4	17.0 (6.4 - 483.3)
DBIL (umol/L)	8.6 ± 26.8	4.9 (0.8 - 398.2)
IBIL (umol/L)	14.8 ± 14.9	11.9 (0.8 - 221.5)
ALB (g/L)	40.6 ± 5.4	40.8 (23.8 - 54.2)
ALT (U/L)	52.1 ± 68.2	34.0 (3.0 - 893.0)
AST (U/L)	62.1 ± 109.6	37.7 (13.4 - 1560.0)
ALP (U/L)	128.3 ± 102.0	107.0 (24.0 - 1743.0)
GGT (U/L)	102.4 ± 119.1	62.0 (13.0 - 1079.0)
BUN (mmol/L)	5.5 ± 1.8	5.2 (2.2 - 18.4)
CR (umol/L)	72.4 ± 16.1	71.8 (36.8 - 166.2)
K (mmol/L)	4.0 ± 0.4	4.0 (2.9 - 5.8)
Na (mmol/L)	139.6 ± 2.4	139.6 (126.8 - 150.0)
Ca (mmol/L)	2.3 ± 0.1	2.3 (1.8 - 3.1)
PT (second)	12.5 ± 1.5	12.2 (10.0 - 29.1)
APTT (second)	30.9 ± 5.7	29.9 (18.9 - 67.3)
INR	1.1 ± 0.1	1.1 (0.9 - 2.5)
Hepatic encephalopathy (No/Grade I-II/Grade III-IV)	421/0/0	
Child-Pugh class (A/B/C)	394/27/0	
Child-Pugh score	5.3 ± 0.7	5.0 (5.0 - 8.0)
MELD score	5.1 ± 3.2	4.9 (−2.5 - 25.4)
ALBI grade (1/2/3)	240/168/13	
ALBI score	−2.6 ± 0.5	−2.7 (−3.8 - (−0.9))
MELD-Na score	−2.2 ± 5.3	−2.7 (−20.1 - 38.5)

Abbreviations: ALB, albumin; ALBI, albumin-bilirubin; ALP, alkaline phosphatase; ALT, alanine aminotransferase; APTT, activated partial thromboplastin time; AST, aspartate aminotransferase; BUN, blood urea nitrogen; CR, creatinine; DBIL, direct bilirubin; GGT, gamma-glutamyl transpeptidase; IBIL, indirect bilirubin; INR, international normalized ratio; MELD, model for end-stage liver disease; PLT, platelet; PT, prothrombin time; RBC, red blood count; SD, standard deviation; TBIL, total bilirubin; WBC, white blood count.

Table S3. Baseline characteristics of patients with ascites.

Variables	Mean ± SD or Frequency (percentage)	Median (Range)
Sex (male/female)	65/9	
Age (years)	55.2 ± 10.3	53.5 (30.0 - 74.0)
Causes of liver diseases, n (%)		
Hepatitis B virus	67 (90.5)	
Hepatitis C virus	1 (1.4)	
Alcohol	3 (4.1)	
Unknown	3 (4.1)	
Vital signs		
Systolic blood pressure (mmHg)	120.1 ± 15.2	116.5 (90.0 - 155.0)
Diastolic blood pressure (mmHg)	75.7 ± 12.8	75.0 (50.0 - 105.0)
Heart rate (b.p.m.)	84.0 ± 14.9	80.0 (57.0 - 123.0)
Laboratory tests		
RBC (10^{*12}/L)	3.9 ± 0.9	3.9 (1.8 - 6.4)
Hb (g/L)	116.7 ± 26.4	120.0 (51.0 - 173.0)
WBC (10^{*12}/L)	4.7 ± 2.3	4.2 (1.1 - 13.2)
PLT (10^{*9}/L)	119.0 ± 101.2	89.5 (6.0 - 491.0)
TBIL (umol/L)	49.5 ± 76.2	26.2 (4.1 - 419.8)
DBIL (umol/L)	21.0 ± 40.9	9.4 (2.0 - 258.7)
IBIL (umol/L)	28.1 ± 44.0	17.2 (1.5 - 314.1)
ALB (g/L)	33.8 ± 5.5	33.9 (21.7 - 49.9)
ALT (U/L)	71.5 ± 101.8	44.1 (12.9 - 699.8)
AST (U/L)	136.9 ± 240.5	70.6 (20.2 - 1810.1)
ALP (U/L)	179.6 ± 132.2	150.5 (58.0 - 904.0)
GGT (U/L)	192.6 ± 204.5	124.0 (7.0 - 906.0)
BUN (mmol/L)	6.1 ± 2.5	5.3 (2.4 - 15.9)
CR (umol/L)	69.6 ± 16.4	68.6 (35.1 - 127.3)
K (mmol/L)	4.0 ± 0.5	4.0 (2.8 - 5.5)
Na (mmol/L)	137.9 ± 4.2	138.5 (120.0 - 147.0)
Ca (mmol/L)	2.2 ± 0.1	2.2 (1.9 - 2.5)
PT (second)	14.2 ± 2.4	13.7 (11.5 - 28.5)
APTT (second)	34.9 ± 9.0	32.4 (21.9 - 74.8)
INR	1.2 ± 0.2	1.2 (1.0 - 2.2)
Ascites (Mild/Moderate-Severe)	51/23	
Hepatic encephalopathy (No/Grade I-II/Grade III-IV)	74/0/0	
Child-Pugh class (A/B/C)	24/42/8	
Child-Pugh score	7.6 ± 1.4	7.0 (6.0 - 11.0)
MELD score	7.8 ± 4.5	7.5 (−3.4 - 21.6)
ALBI grade (1/2/3)	9/52/13	
ALBI score	−1.9 ± 0.6	−2.0 (−3.3 - (−0.2))
MELD-Na score	3.1 ± 9.8	2.2 (−17.7 - 43.9)

Abbreviations: ALB, albumin; ALBI, albumin-bilirubin; ALP, alkaline phosphatase; ALT, alanine aminotransferase; APTT, activated partial thromboplastin time; AST, aspartate aminotransferase; BUN, blood urea nitrogen; CR, creatinine; DBIL, direct bilirubin; GGT, gamma-glutamyl transpeptidase; IBIL, indirect bilirubin; INR, international normalized ratio; MELD, model for end-stage liver disease; PLT, platelet; PT, prothrombin time; RBC, red blood count; SD, standard deviation; TBIL, total bilirubin; WBC, white blood count.