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Albumin-Bilirubin (ALBI) as an accurate and simple prognostic score for chronic hepatitis B-related liver cirrhosis

Jian Wang[a,1], Zhaoping Zhang[a,1], Xiaomin Yan[a], Ming Li[b], Juan Xia[a], Yong Liu[c], Yuxin Chen[c], Bei Jia[a], Li Zhu[b], Chuanwu Zhu[b,**], Rui Huang[a,*], Chao Wu[a,*]

[a] Department of Infectious Diseases, Nanjing Drum Tower Hospital, The Affiliated Hospital of Nanjing University Medical School, Nanjing, Jiangsu, China
[b] Department of Hepatology, The Fifth People's Hospital of Suzhou, Suzhou, Jiangsu, China
[c] Department of Laboratory Medicine, Nanjing Drum Tower Hospital, The Affiliated Hospital of Nanjing University Medical School, Nanjing, Jiangsu, China

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ABSTRACT

Background: The Albumin–Bilirubin (ALBI) score was developed to predict the long-term prognosis of hepatocellular carcinoma patients. We aimed to investigate the performance of ALBI for predicting severity and long-term prognosis of chronic hepatitis B-related liver cirrhosis (CHB-LC).
Methods: CHB-LC patients were enrolled from two medical centers between 2011 and 2017. The prognostic performance of ALBI was evaluated and compared with Child-Turcotte-Pugh (CTP), model of end-stage liver disease (MELD) and MELD integrating sodium (MELD-Na) scores.
Results: This study enrolled 398 CHB-LC patients and patients were followed up for a median of 33.9 (IQR 21.6–48.8) months. The ALBI (HR: 3.151, 95% CI: 2.039–4.869,$P < 0.001$) was identified as an independent predictor of liver-related mortality. The receiver operating characteristic curves (ROCs) analysis revealed that ALBI score (0.756, 0.745, 0.739, 0.767 and 0.765) was superior to MELD score ($P < 0.05$) and comparable with CTP score ($P > 0.05$) for predicting 2-year, 3-year, 4-year, 5-year and global mortality. The AUROCs of ALBI score were significantly higher than MELD-Na score($P < 0.05$) for predicting 2-year, 3-year and 5-year mortality. Patients with lower ALBI grade had a significantly lower mortality than patients with higher ALBI grade ($P < 0.05$).
Conclusions: ALBI score accurately predicts the severity and long-term prognosis of patients with CHB-LC. The prognostic performance of ALBI score was superior to MELD and MELD-Na score.

1. Introduction

Liver cirrhosis (LC) is a common end-stage liver disease, which is an important cause of morbidity and mortality. Hepatitis B virus (HBV) infection remains a major cause of chronic hepatitis B (CHB)-related LC (CHB-LC) in China [1]. Accurate, objective, and simple prognosticate scores are essential to guide management strategy in CHB-LC patients. Child-Turcotte-Pugh (CTP) and Model for End-Stage Liver Disease (MELD) scores are the most widely used scoring systems for predicting the prognosis of LC patients. The CTP score incorporates five variables including total bilirubin (Tbil), serum albumin (ALB), prothrombin time (PT), severity of ascites, and degree of hepatic encephalopathy (HE) [2]. However, the accuracy is inevitably influenced by the subjective criteria such as HE and ascites [3]. The MELD score includes three objective parameters, Tbil, international normalized ratio (INR) and creatinine (Cr) [4]. Though Biggins et al. reported that MELD score is better than CTP score in predicting wait-list mortality of liver transplantation [5], early mortality still happens in patients with low baseline MELD score and MELD score could not correctly evaluate mortality in about 20% of patients [6]. MELD score is specifically designed for patients with end-stage liver disease only, but not for patients with LC in general [4]. In addition, MELD integrating sodium (MELD-Na) score was reported by Biggins et al. to predict the prognosis of patients with waiting liver transplantation and was expected to provide better prediction of wait-list mortality [7–9].

Recently, Albumin–Bilirubin (ALBI) grade which only includes two parameters was developed by Johnson et al. in patients with hepatocellular carcinoma (HCC) for assessing the severity of liver dysfunction [10]. Pinato et al. validated the value of ALBI for predicting overall mortality in a cohort of HCC patients

* Corresponding authors at: Department of Infectious Diseases, Nanjing Drum Tower Hospital, The Affiliated Hospital of Nanjing University Medical School, Nanjing 210008, Jiangsu, China.
** Corresponding author at: Department of Hepatology, The Fifth People's Hospital of Suzhou, Suzhou 215007, Jiangsu, China.
E-mail addresses: zhuchw@126.com (C. Zhu), doctor_hr@126.com (R. Huang), dr.wu@nju.edu.cn, wuchao1962@163.com (C. Wu).
[1] The authors contributed equally.

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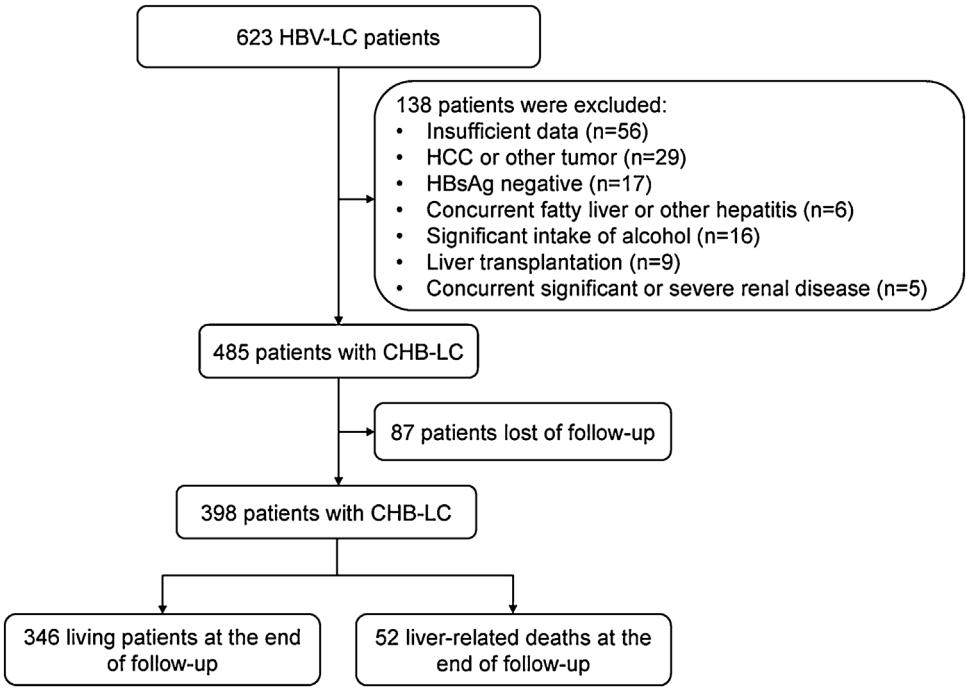

Fig. 1. Flow diagram of the enrolled population.

who underwent resection, transarterial chemoembolization, and sorafenib treatment [11]. The ALBI score was also demonstrated to be a prognostic factor and provided better/similar prognostic performance compared to other prognostic scores in patients with primary biliary cirrhosis (PBC) [12]. ALBI score could predict the 3-month mortality rate in patients with HBV-related acute-on-chronic liver failure [13]. In addition, one study also reported that ALBI score could predict the prognosis for patients with CHB-LC [14]. However, this study did not verify the correlation between ALBI score and the severity of LC and the follow-up period was relatively short. Therefore, the objective of this study was to investigate the performance of ALBI for predicting the severity and long-term prognosis of CHB-LC.

2. Methods

2.1. Patients

We retrospectively enrolled the CHB-LC patients who were admitted to the Nanjing Drum Tower Hospital (Nanjing, China) and Fifth People's Hospital of Suzhou (Suzhou, China) between January 2011 and March 2017. The diagnosis of LC was based on pathology, ultrasound findings or radiological signs of cirrhosis [15], and decompensated cirrhosis was defined as a history of ascites, esophageal variceal bleeding (EVB), HE in patients with known CHB [16]. The inclusion criteria included was that previously diagnosed with CHB-LC before enrolling and without current evidence of HCC. The inclusion criteria were as follows: (1) Co-infection with hepatitis A virus, hepatitis C virus, hepatitis D virus, hepatitis E virus or human immunodeficiency virus; (2) combination of HCC or other types of malignancy at or before the baseline; (3) co-existence of other causes of liver disease such as autoimmune hepatitis, PBC, alcoholic liver disease, non-alcoholic steatohepatitis, hemochromatosis, alpha-1 antitrypsin deficiency or Wilson's disease; (4) other severe diseases in aspect of cardiac, renal, respiratory, hematological or psychiatric; (5) underwent organ transplantation before the enrollment.

2.2. Clinical data collection and follow-up

The baseline clinical data of patients after admission was collected from the electronic medical charts of two centers. Patients were followed up for a median time of 33.9 months. Dates and causes of death were obtained via review of institutional records, patient interview and/or interview of family members. Survival time was defined from the date that the biomarker was carried out to the endpoint date. The main endpoint was liver-related mortality. The interval was censored at the time of last follow-up. The study was approved by the Institutional Review Board of Nanjing Drum Tower Hospital (Nanjing, China) and The Fifth People's Hospital of Suzhou (Suzhou, China).

2.3. Calculation of scores

The CTP score were calculated by five variables, including Tbil, ALB, INR, degree of HE and ascites status [2].

MELD score = $9.57 \times \ln$ (Cr (μmol/L)/88.41) + $3.78 \times \ln$ (Tbil (μmol/L)/17.1) + $11.2 \times \ln$ (INR) + 6.43 [17].

MELD-Na score = MELD + $1.59 \times$ (135-Na), the minimum value for serum Na is 120 mmol/L and the maximum 135 mmol/L [7].

ALBI score = $-0.085 \times$ (Alb g/L) + $0.66 \times \lg$(Tbil μmol/L). ALBI was classified into three grades: grade 1: ≤ -2.6, grade 2: > -2.6, ≤ -1.39, and grade 3: > -1.39 [10].

2.4. Statistical analysis

All data analysis was performed using SPSS version 22.0 software (SPSS Inc., Chicago, IL, United States) and SigmaPlot version 12.5 (Systat Software Inc., San Jose, CA, United States). Continuous variables were presented as median (interquartile range [IQR]) and category variables were expressed as frequency or percentage. Differences in variables were analyzed using a one-way ANOVA and Student t tests or the Kruskal–Wallis and Mann–Whitney U tests. The correlation between two variables was assessed using the Spearman rank correlation test. The diagnostic performance of different indexes was evaluated by receiver operating character-

Table 1
Baseline characteristics of patients with chronic hepatitis B-related liver cirrhosis.

	CHB-LC (n = 398)
Age (years) (IQR)	50.0 (43.0, 59.0)
Male (%)	292 (73.4)
Hb (g/L) (IQR)	120.0 (100.0, 137.0)
PLT (10^9/L) (IQR)	65.0 (43.0, 106.0)
ALT (U/L) (IQR)	47.0 (35.0, 88.0)
AST (U/L) (IQR)	57.0 (38.0, 91.3)
ALP (U/L) (IQR)	100.6 (79.0, 129.0)
GGT (U/L) (IQR)	57.0 (35.0, 101.0)
TBIL (μmol/L) (IQR)	28.0 (17.5, 49.8)
ALB (g/L) (IQR)	32.7 (28.4, 38.7)
Cr (μmol/L) (IQR)	61.1 (53.9, 68.0)
Na^+ (mmol/L) (IQR)	140.2 (137.6, 142.4)
PT (s) (IQR)	15.9 (14.5, 18.1)
HBV-DNA (log_{10} IU/mL) (IQR)	4.9 (3.6, 5.9)
HBeAg positive (%)	110 (27.6)
CTP score (IQR)	7.0 (6.0, 9.0)
CTP class (A/B/C) (%)	49.7/37.9/12.3
MELD score (IQR)	8.2 (4.7, 12.1)
MELD-Na score (IQR)	8.4 (4.8, 12.1)
ALBI score (IQR)	−1.8 (−2.4, −1.3)
ALBI grade (1/2/3) (%)	20.6/62.6/16.8
Antiviral treatment (%)	278 (69.8)

Hb, hemoglobin; PLT, platelets; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma-glutamyl transferase; TBIL, total bilirubin; ALB, albumin; Cr, creatinine; PT, prothrombin time; HBeAg, hepatitis B e antigen; CHB-LC, chronic hepatitis B related liver cirrhosis; IQR, interquartile range.

istic curve (ROC). Differences between the area under ROC curve (AUROC) were tested using the z-test. The optimal cut-off values were determined by the Youden's index. Univariable and multivariable Cox proportional hazard model was carried out to identify independent factors for liver related mortality. Survival estimates for different groups were generated using Kaplan–Meier method. Log-rank test was used to test the equivalences of the survival curves. A two-tailed P < 0.05 was considered statistically significant.

3. Results

3.1. Study population

A total of 623 CHB-LC patients were enrolled in the study. Overall, 82 patients were excluded according to the exclusion criteria. 56 patients were excluded because of insufficient data and 87 patients were excluded due to loss to follow-up. 398 patients were included for the final analysis (Fig. 1). The baseline characteristics of 398 CHB-LC patients were shown in Table 1. 292 patients (73.4%) were male, and the median age was 50 (IQR 43.0–59.0) years. Patients had a median CTP score of 7.0 (IQR 6.0–9.0) (CTP class A 49.7%, CTP class B 37.9%, CTP class C 12.3%), a median MELD of 8.2 (IQR 4.7–12.1), a median MELD-Na of 8.4 (IQR 4.8–12.1), and a median ALBI score of −1.8 (IQR −2.4 to −1.3) (grade 1 20.6%, grade 2 62.6%, and grade 3 16.8%). Patients were followed up for a median duration of 33.9 (IQR 21.6–48.8) months.

3.2. Comparison of ALBI scores according the severity of CHB-LC

ALBI scores were significantly higher in patients with decompensated cirrhosis (−1.8, IQR −2.2 to −1.4) than patients with compensated cirrhosis (−2.6, IQR −2.8 to −2.2, P < 0.001). Similar results were observed for CTP, MELD and MELD-Na scores (P < 0.001). However, ALBI was the only score that was consistently associated with the presence of each clinical decompensating event (EVB, HE and ascites) (P < 0.05). There were no significant differences in terms of CTP, MELD and MELD-Na scores between EVB and non-EVB groups (P > 0.05) (Supplemental Fig. 1). In addition, patients with liver-related mortality (−1.4, IQR −1.7 to −1.1) had significantly higher ALBI values compared to the survival group (−2.1, IQR −2.5 to −1.7, P < 0.001). Similar results were found with CTP, MELD and MELD-Na scores (P < 0.001) (Supplemental Fig. 2).

3.3. Correlations of ALBI scores with CTP, MELD and MELD-Na scores

Patients with CTP class C (−1.1, IQR −1.3 to −0.8) had significantly higher ALBI score as compared with CTP class B group (−1.7, IQR −2.0 to −1.5, P < 0.001) and CTP class A group (−2.4, IQR −2.8 to −2.1, P < 0.001). ALBI scores were positively correlated with CTP scores (r = 0.843, P < 0.001), MELD scores (r = 0.555, P < 0.001) and MELD-Na scores (r = 0.571, P < 0.001) (Supplemental Fig. 3).

3.4. Univariable and multivariable Cox regression analysis for CHB-LC patients

Univariable Cox regression analysis showed that age (HR, 1.064; 95% CI 1.039–1.089; P < 0.001), Tbil (HR, 1.007; 95% CI 1.004–1.010; P < 0.001), ALB (HR, 0.883; 95% CI 0.846–0.922; P < 0.001) and ALBI (HR, 3.729; 95% CI 2.430–5.723; P < 0.001) were associated with liver-related mortality. Subsequently, on multivariable Cox proportional hazard regression analysis, only ALBI (HR, 3.151; 95% CI 2.039–4.869; P < 0.001) and age (HR, 1.049; 95% CI 1.025–1.073; P < 0.001) were significantly independent predictors for mortality of CHB-LC (Table 2).

3.5. ALBI for predicting liver-related mortality of CHB-LC patients

Predictive values of four models for prognosis of CHB-LC by ROC curves at 1, 2, 3, 4, 5 years of follow-up were evaluated (Fig. 2,

Table 2
Univariate and multivariate Cox proportional hazards analysis for liver-related mortality of chronic hepatitis B-related liver cirrhosis.

Variables	Univariate HR (95%CI)	P value	Multivariate HR (95%CI)	P value
Age	1.064 (1.039, 1.089)	<0.001	1.049 (1.025, 1.073)	<0.001
Sex	1.087 (0.580, 2.036)	0.795		
PLT	0.999 (0.994, 1.003)	0.482		
ALT	0.999 (0.995, 1.002)	0.414		
AST	1.000 (0.998, 1.003)	0.868		
GGT	1.000 (0.996, 1.004)	0.908		
TBIL	1.007 (1.004, 1.010)	<0.001		
ALB	0.883 (0.846, 0.922)	<0.001		
Cr	1.005 (0.991, 1.019)	0.469		
PT	1.028 (0.961, 1.100)	0.426		
ALBI	3.729 (2.430, 5.723)	<0.001	3.151 (2.039, 4.869)	<0.001
Antiviral treatment	0.741 (0.421, 1.304)	0.299		

PLT, platelets; ALT, alanine aminotransferase; AST, aspartate aminotransferase; GGT, gamma-glutamyl transferase; TBIL, total bilirubin; ALB, albumin; Cr, creatinine; PT, prothrombin time; HR, hazard ratios; CI, confidence interval.

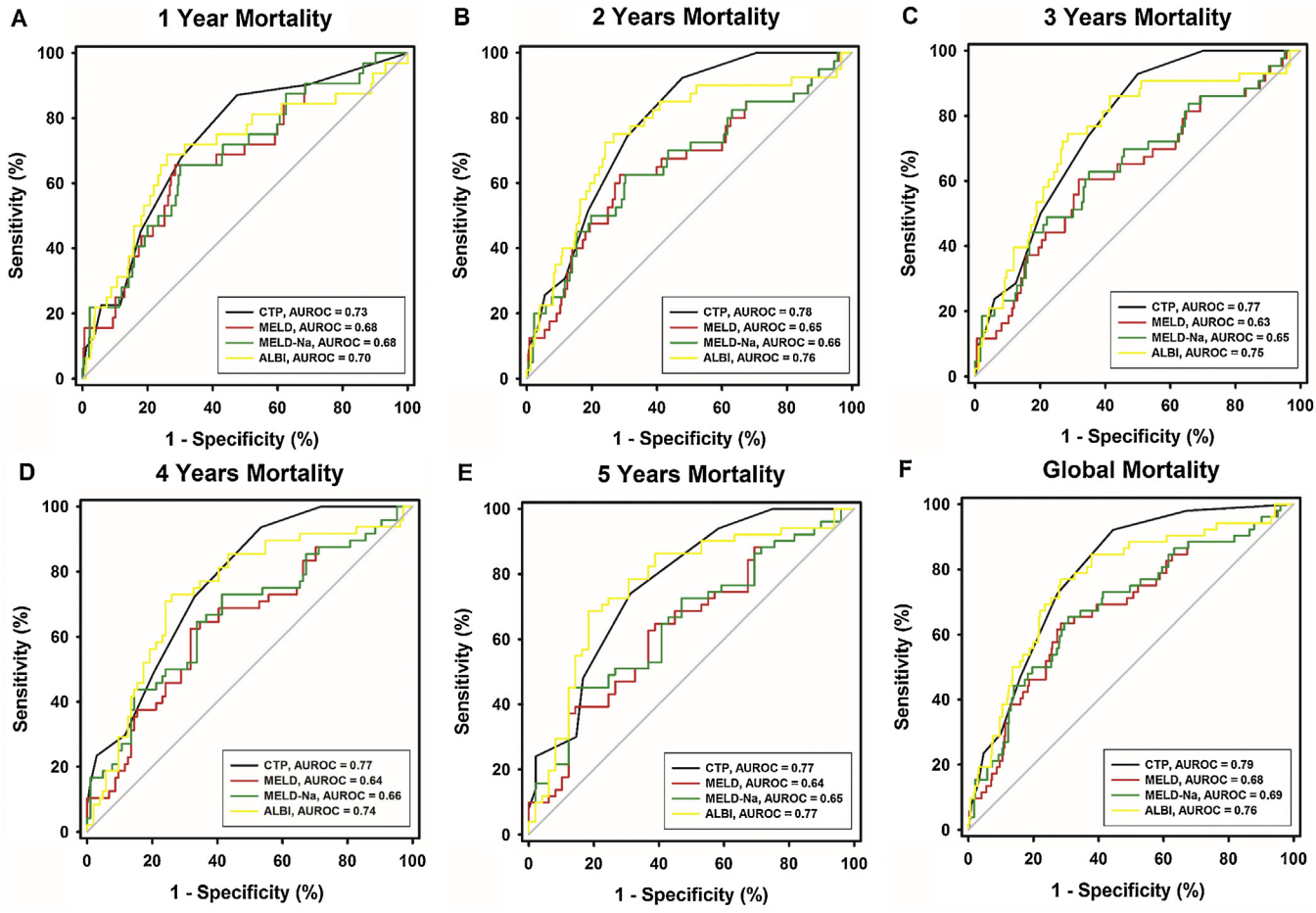

Fig. 2. Receiver operating characteristic (ROC) curves of Child-Turcotte-Pugh, MELD, MELD-Na and ALBI scores in the prediction of liver-related mortality at the different time points of follow-up.

Table 3). The AUROC of ALBI scores (0.700, 95%CI 0.593–0.808) showed no significant difference in the prediction of 1-year liver-related mortality when compared with CTP (0.731, 95%CI 0.642–0.819, P = 0.318), MELD (0.677, 95%CI 0.577–0.777, P = 0.685) and MELD-Na scores (0.683, 95%CI 0.584–0.782, P = 0.758). However, for the prediction of 2-year, 3-year, 4-year and 5-year liver-related mortality, AUROCs of ALBI score (0.756, 0.745, 0.739 and 0.767) were comparable with CTP score (0.785, 0.766, 0.768 and 0.772, P > 0.05), but were significantly higher than that of MELD score (0.655, 0.629, 0.641 and 0.636, P < 0.05). Furthermore, the AUROCs of ALBI score were also significantly higher than that of MELD-Na score (0.662, 0.646 and 0.651, P < 0.05) for 2-year, 3-year and 5-year liver-related mortality. In terms of global mortality, AUROCs of ALBI (0.765, 95%CI 0.693–0.837) were significantly higher than that of MELD score (0.677, 95%CI 0.595–0.759, P < 0.05), but was also comparable with CTP score (0.793, 95%CI 0.738–0.848, P > 0.05) and MELD-Na score (0.688, 95%CI 0.606–0.770, P > 0.05).

We also added the conventional cutoff values of 10 and 15 for MELD score to validate diagnostic performance [4,18,19]. In general, the MELD score could predict liver-related mortality with only inferior sensitivities (10%–50%) and moderate specificities (68%–95%).

3.6. Prediction of ALBI score for cumulative mortality in CHB-LC patients

CHB-LC patients were followed up for a median time of 33.9 months (IQR 21.6–48.8 months). Cumulative mortality from liver-related cause was 13.1% overall (52 deaths). Patients with ALBI grade 3 (34.3%) had a significantly higher mortality than patients with grade 2 (10.4%, P < 0.001) and grade 1 (3.7%, P < 0.001). Meanwhile, patients with ALBI grade 1 had a significantly lower mortality than patients with grade 2 (P = 0.044). Further analysis was performed to evaluate the predicting ability of CTP score. The mortality probability of patients with CTP class A (2.5%) was lower than that of class B (21.2%) (P < 0.001) and class C (30.6%) (P < 0.001), but the mortality probability of patients with CTP class C was comparable to CTP class B patients (P = 0.175). In addition, in the CTP class A and B subgroup, patients at ALBI grade 1 (3.7%) had favorable survival probability when compared with patients at ALBI grade 2 (10.8%) (P = 0.037) and grade 3 (30.8%) (P < 0.001). Patients with ALBI grade 2 also had a significantly lower mortality than patients with grade 3 (P = 0.006) (Fig. 3).

4. Discussion

ALBI was initially developed to evaluate the hepatic function in patients with HCC, which contains only two simple parameters of ALB and Tbil [10]. ALB is produced by liver and as a multifunctional protein with antioxidant, immunomodulatory, and detoxification functions [20]. Decreased ALB levels generally imply disorder of liver function and a poor prognosis in patients with LC [21]. In addition, Tbil is also an important index of liver function. There are several advantages about ALBI score. ALBI is a simple score and applicable to different stages of chronic liver disease. The ALBI score only involves two common parameters as compared with other

Table 3
AUROCs of CTP score, MELD score and ALBI score for predicting the 1 year, 2 years, 3 years, 4 years, 5 years and global mortality of chronic hepatitis B-related liver cirrhosis.

	Optimized cutoff	Sensitivity (%)	Specificity (%)	AUC (95%CI)	LR +	LR −	P value	P value of ROC contrast test*
1-year mortality								
CTP score	6.0	87.10	52.47	0.731 (0.642, 0.819)	1.833	0.246	<0.001	0.318
MELD score	9.32	65.63	71.51	0.677 (0.577, 0.777)	2.304	0.481	<0.001	0.685
	10.0	46.43	74.79		1.842	0.716	0.014	–
	15.0	17.86	94.52		3.259	0.869	0.010	–
MELD-Na score	9.50	65.63	69.95	0.683 (0.584, 0.782)	2.184	0.491	<0.001	0.758
ALBI score	−1.66	68.75	74.04	0.700 (0.593, 0.808)	2.648	0.422	<0.001	–
2-years mortality								
CTP score	6.0	92.31	52.21	0.785 (0.723, 0.847)	1.932	0.147	<0.001	0.377
MELD score	9.32	62.50	71.43	0.655 (0.555, 0.754)	2.188	0.525	0.002	0.032
	10.0	47.50	75.09		1.907	0.699	0.003	–
	15.0	11.36	94.77		2.172	0.935	0.112	–
MELD-Na score	9.50	62.50	69.71	0.662 (0.563, 0.762)	2.063	0.538	<0.001	0.046
ALBI score	−1.61	72.50	75.91	0.756 (0.669, 0.843)	3.010	0.362	<0.001	–
3-years mortality								
CTP score	6.0	92.86	50.00	0.766 (0.699, 0.832)	1.857	0.143	<0.001	0.515
MELD score	9.27	60.47	68.11	0.629 (0.531, 0.726)	1.896	0.580	0.009	0.012
	10.0	44.19	72.43		1.603	0.771	0.033	–
	15.0	11.63	93.51		1.792	0.876	0.248	–
MELD-Na score	9.27	62.79	65.05	0.646 (0.549, 0.744)	1.797	0.572	0.003	0.030
ALBI score	−1.67	74.42	71.51	0.745 (0.660, 0.830)	2.612	0.358	<0.001	–
4-years mortality								
CTP score	6.0	93.62	46.60	0.768 (0.695, 0.842)	1.753	0.137	<0.001	0.370
MELD score	9.15	62.50	68.27	0.641 (0.544, 0.737)	1.970	0.549	0.006	0.043
	10.0	45.83	71.15		1.589	0.761	0.040	–
	15.0	10.42	93.27		1.548	0.960	0.433	–
MELD-Na score	7.94	72.92	58.65	0.664 (0.567, 0.760)	1.764	0.462	0.001	0.112
ALBI score	−1.67	72.92	74.04	0.739 (0.652, 0.827)	2.809	0.366	<0.001	–
5-years mortality								
CTP score	7.0	74.00	68.75	0.772 (0.681, 0.863)	2.368	0.378	<0.001	0.879
MELD score	9.15	62.75	63.27	0.636 (0.527, 0.746)	1.708	0.589	0.019	0.020
	10.0	47.06	68.75		1.506	0.770	0.142	–
	15.0	11.76	90.00		1.176	0.980	0.548	–
MELD-Na score	11.85	45.10	87.76	0.651 (0.543, 0.759)	3.685	0.626	0.009	0.034
ALBI score	−1.64	68.63	81.63	0.767 (0.670, 0.864)	3.736	0.384	<0.001	–
Global mortality								
CTP score	6.0	92.16	55.52	0.793 (0.738, 0.848)	2.072	0.141	<0.001	0.283
MELD score	9.16	63.46	71.59	0.677 (0.595, 0.759)	2.234	0.510	<0.001	0.035
	10.0	48.08	74.77		1.906	0.525	0.001	–
	15.0	11.54	94.49		2.094	0.936	0.095	–
MELD-Na score	9.16	65.38	69.36	0.688 (0.606, 0.770)	2.134	0.499	<0.001	0.058
ALBI score	−1.75	76.92	71.68	0.765 (0.693, 0.837)	2.716	0.322	<0.001	–

*Compared with ALBI score. AUROC, area under the receiver operating characteristic curve; CI, confidence interval; LR-, negative likelihood ratio; LR+, positive likelihood ratio.

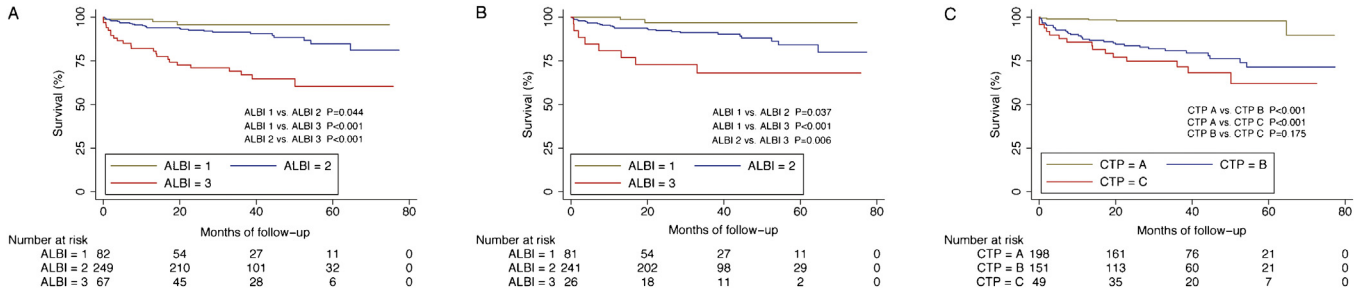

Fig. 3. Kaplan–Meier curve of survival from liver-related mortality for ALBI index in patients with chronic hepatitis B-related liver cirrhosis (CHB-LC) in the entire patients (A) and Child-Turcotte-Pugh (CTP) class A and B patients (B). Kaplan–Meier curve of survival from liver-related mortality for different CTP groups in the entire patients (C).

prognostic scores. ALB and Tbil are easily acquired in clinical practice and the calculation formula is relatively simple. As compared to CTP score, ALBI score avoids the subjective bias in determining the degree of ascites and HE. Moreover, the variables of CTP score including ALB, Tbil and PT were selected empirically and the cut-off values were defined arbitrarily. MELD and MELD-Na scores are based on objective laboratory values but is specifically designed for patients with end-stage liver disease only and the computational formulae are complicated.

ALBI had an equally good ability in predicting the prognosis of HCC patients as compared with CTP by two large cohorts [10]. Since then, many studies have validated the value of ALBI in assessing the survival of HCC patients and shown ALBI was an independent predictor of survival in patients with HCC [11,22–24]. In aspect of liver failure, a retrospective study by Chen et al. showed a high ALBI score was an independent predictor for the 3-month mortality possibility in patients with HBV-related liver failure [13]. However, Peng et al. reported ALBI score might be ineffective in predicting

the in-hospital mortality of cirrhosis with acute-on-chronic liver failure [25]. Another study indicated that ALBI was an independent prognostic factor for estimating the clinical outcome of patients with PBC and provides better/similar prognostic performance as compared with CTP score and MELD score [12].

In the present study, we identified that ALBI score was consistently correlated with the severity of CHB-LC. In addition, ALBI score was also an independent predictor of liver-related mortality by multivariate Cox analysis. Though ALBI score contains only two simple parameters as compared with CTP (five parameters) score and MELD score (three parameters), it remains correctly categorizes the degree of severity in patients with CHB-LC. The most important finding of this study is the predictive value of ALBI on long-term prognosis in patients with CHB-LC overall. The liver-related mortality rate of CHB-LC patients with ALBI grade 3 (34.3%) was near triple higher compared to patients with ALBI grade 2 (10.4%) and near tenfold higher compared to those with ALBI grade 1 (3.7%) at the end of follow-up. The liver-related mortality rate of patients with ALBI grade 2 also was significantly higher than that of patients with ALBI grade 1. The results were consistent with previous findings by Chen et al. [14]. However, we had a longer follow-up period and we analyzed the relation between ALBI and severity of CHB-LC in this study. Subgroup analysis was performed in patients with CTP class A and B and ALBI score remains stratify patients into three prognostically different groups. The results suggested that ALBI also was a good prognostic predictor in patients with early stage LC. Similar finding by Oh et al demonstrated that ALBI grade was an independent factor associated with overall survival in patients with early stage HCC treated with RF ablation [26]. Chen et al. reported that the separation of the survival curves among 3 ALBI grades also was apparent among patients with CTP class B and C [14]. However, due to limited sample in CTP class C (n = 49), we could not analyze the predicting ability of ALBI in this subgroup. Patients with CTP class A had higher survival rate than CTP class B and C patients. However, the significant differences of survival rate were not observed between patients with CTP class B and C in the present study. Though CTP score is commonly used to assess the prognosis of patients with LC, the accuracy is inevitably influenced by subjective assessment of ascites and HE [3].

The ROCs of ALBI score, CTP score, MELD score and MELD-Na were performed according to different time points. The AUROC of ALBI score for predicting 1-year liver-related mortality was comparable with other three models in the present study. However, ALBI score showed a significantly better predicting performance than MELD score for predicting 2-year, 3-year, 4-year and 5-year and MELD-Na score for predicting 2-year, 3-year and 5-year liver-related mortality in CHB-LC patients, but there were no significant differences between ALBI score and CTP score in these time points. The results were slightly different with another research which reported that ALBI score was significantly better than CTP and MELD scores in predicting the 1, 2, 3-years prognosis [14]. The reason could be interpreted as majority of patients (80.5%) were CTP class B and C in the study by Chen et al, while only half of patients in our cohort were severe LC (CTP class B/C, 50.3%). Previous studies have reported that integrating serum sodium into the MELD score (MELD-Na) resulted in better performance in predicting mortality than the MELD score in patients with cirrhosis [7]. However, to the best of our knowledge, no study has compared the value of between ALBI score and MELD-Na score for predicting long-term mortality in patients with HBV-related cirrhosis. Our results showed that the predictive performance of ALBI score for liver-related mortality of CHB-LC patients was superior to MELD-Na. The reason may be explained that MELD-Na score was originally proposed to predict prognosis in patients with waiting liver transplantation, while more than 30% patients were compensatory liver cirrhosis in our study. Therefore, further prospective and large sample studies are needed to validate the predicting value between ALBI score and MELD-Na score.

In conclusion, our results revealed that ALBI score is a simple score derived from an easily-accessible and non-invasive blood test without using those factors evaluated subjectively for evaluating the severity of CHB-LC. ALBI score as a predicting index with a good performance in assessing long-term prognosis and provides a better prognostic ability compared to MELD scores in patients with CHB-LC. Though the performance of ALBI was no superior to CTP score in predicting the long-term prognosis of CHB-LC patients, it is convenient to use in clinical practice due to only contains two routinely objective parameters and simple calculation. Since this is a retrospective study which only enrolled patients from two centers, prospective studies with more centers are required to confirm the predicting ability of ALBI for long-term prognosis in patients with CHB-LC. Furthermore, the predicting performance of on-treatment ALBI for long-term prognosis of CHB-LC patients deserves further investigation.

Competing interests

None declared.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.dld.2019.01.011.

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