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ORIGINAL RESEARCH ARTICLE

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CHIBA score: a novel model for predicting 3-month mortality in a cohort of Decompensated Liver Disease (DCLD)

Shanid Abdul Sathar* and Jijo Vargheese

Abstract

Background Decompensated liver disease (DCLD) has high mortality, and its prediction is important to prognosticate and prioritize patients for liver transplantation. MELD, MELD variants, and CTP were widely tested for mortality prediction with few drawbacks. The aim of the study is to propose a new prognostic model for DCLD which is better than the existing scores.

Materials and methods Retrospective study with 321 DCLD patients were enrolled. Patient relatives were telephonically contacted regarding date of death, and mortality at 3 months was assessed. Logistic regression was done, coefficient of beta of independent variables were found out, and a new CHIBA score was proposed.

CHIBA score = creatinine × 0.6 + HE × 0.4+ INR × 0.8 + bilirubin × 0.125 + ascites × 1.2) where C stands for creatinine, H for hepatic encephalopathy, I for INR, B for bilirubin, and A for ascites.

Results CHIBA score has AUROC of 0.793 (at a cutoff of > 5.5, it has a sensitivity of 66% and specificity of 76%) compared to MELD-Na of 0.735 (cutoff > 25, sensitivity 65%, and specificity 72%); MELD of 0.727 (cutoff > 17 sensitivity of 80.37% and specificity of 55.14%); I-MELD of 0.72; MESO index of 0.72; and UKELD of 0.686. For validation, 214 patients were selected, and AUROC of CHIBA score in the validation cohort was 0.77. At a cutoff of > 5.5, it has a sensitivity of 60% and specificity of 77%.

Conclusion CHIBA score is superior to MELD and MELD variants in predicting 3-month mortality, and it is validated in an external cohort. It can be calculated at bedside as it is a simple score with no logarithmic variables in it.

Introduction

Decompensated liver disease (DCLD) is one of the most common cause of mortality worldwide, though the etiology varies from place to place. With emergence of NAFLD, the incidence of DCLD is increasing at an alarming rate. Though many therapies for DCLD had been tried, most of them were not able to provide a curative therapy. Liver transplantation is the only curative therapy for DCLD. Because of scarcity of cadaveric donors, identification of most suitable recipients who requires the transplantation is at most important. Many studies have investigated factors predicting survival in patients with cirrhosis [1, 2]. Many scoring systems were proposed for better allocation of organ for transplantation and to decrease the mortality in transplant waiting list. Among them, the most important was MELD and MELD variants. MELD was introduced by Malinchoc for TIPSS patients [3]. But later, it was found to be effective for allocating organs for transplantation candidates based on MELD score [4, 5]. The problem with MELD is that creatinine (one component of MELD) may vary according to muscle mass, and its levels in females were less compared

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to males leading to increased mortality of females in transplantation list. Another drawback of MELD is that it gives maximum weightage for INR which vary with time to time even in same patient. Drawback also includes MELD exceptions like HCC for which mortality cannot be accurately predicted with MELD. To overcome these drawbacks of MELD, various modifications were put forward, and the most important among this was MELD-Na [6, 7]. MELD and its variants are complicated scores with logarithmic variables in it, and it is not able to calculate at bedside. Another predictor model of mortality in CLD patients was CTP score [8]. The problem with CTP score was that it is a subjective score, and that it is not a dynamic score like MELD and does not rate other factors such as renal and pulmonary dysfunction [9, 10] which are common in decompensated cirrhosis.

Numerous studies compared MELD and CTP regarding prediction of 3- and 6-month mortality with varying results. In this study, we compared CTP, MELD, and MELD variants like MELD-Na, UKLED, I-MELD, and MESO score in a cohort of DCLD in predicting 3-month mortality and proposed a new score which can predict mortality better than the existing scores (Table 1).

Materials and methods

It was a retrospective study in a population of DCLD patients with age more than 18 years admitted in Department of Medical Gastroenterology, Trivandrum Medical College, from June 2016-January 2019 after excluding patients with hepatocellular carcinoma, extrahepatic malignancy, and high DF alcoholic hepatitis and patients who died in the same admission.

The study was approved by the Institutional Ethics Review Board of the Hospital, and informed written consent was provided by all patients. Data is collected from the electronically generated discharge summary and telephonic conversation. Clinical and biochemical parameters were collected on the date of admission. Ascites was evaluated clinically and with ultrasound or CT. Hepatic encephalopathy was evaluated clinically at the time of the assessment and using the electronic records and were classified according to the West Haven criteria (grades 1–4). Patient's bystanders were telephonically contacted regarding mortality at 3 months from the time of admission, and death time from date of admission was assessed. Based on admission variables, MELD, CTP, and MELD variants were calculated. Logistic regression of significant variables was done, and a new score (CHIBA score) was proposed (CHIBA score = creatinine × 0.6 + HE × 0.4 + INR × 0.8 + bilirubin × 0.125 + ascites × 1.2). C stands for creatinine, H for hepatic encephalopathy, I for INR, B for bilirubin, and A for ascites. Ascites was further divided into absent or mild with a score of 0, moderate −1, and tense 2. Hepatic encephalopathy is absent with score of 0, grade 1 West Haven score of 1, grade 2 score of 2, and grades 3 and 4 a score of 3. For validation of the CHIBA score, 214 patients were taken which was comparable to the test cohort. AUROC of CHIBA score in the validation cohort was found out.

Statistical analysis

Continuous variables were compared using Student's *t*-tests, and categorical variables were compared using chi-squared tests or Fisher's tests. The predictive ability for each model was evaluated according to areas under receiver-operating characteristics curves (AUROC). Comparisons of AUROCs were performed by MedCalc software version 12.4. The *p*-value was considered significant when it was less than 0.05.

Results

Three-hundred twenty-one patients were taken up for the study (Fig. 1). For validation, 214 patients were taken. Baseline characteristics of the test group and validation cohort were given in Table 2.

Among the quantitative study variables analyzed by *t*-test hemoglobin, platelet count, albumin, creatinine, bilirubin, sodium level, INR, portal vein diameter, liver span, and spleen span were statistically significant in predicting 3-month mortality (Table 3).

Table 1 MELD and MELD variants compared in our study

Score	Equation
MELD	MELD = 3.78 × ln[serum bilirubin (mg/dL)] + 11.2 × ln[INR] + 9.57 × ln[serum creatinine (mg/dL)] + 6.43
MESO index	[MELD/Na (mmol/L)] × 10
I-MELD	MELD + (0.3 × age)−(0.7 + Na) + 100
MELD-Na	[0.025 × MELD × (140−Na)] + 140 sodium < 125 is calculated at 125. Sodium > 140 is calculated at 140
UKLED	5.395 × ln INR + 1.45 ln creatinine + 3.3 ln bilirubin−81.565 ln Na + 435

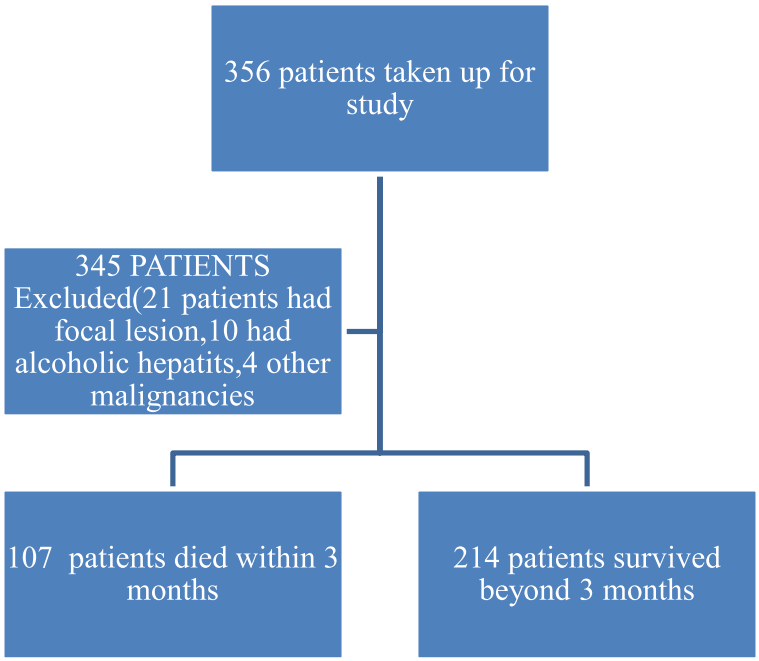


Fig. 1 Consort diagram of the test group

Table 2 Baseline characteristics of test and validation cohort

Variables	Test cohort Mean	Validation cohort Mean
Hemoglobin	9.567290	9.4687200
PLT	0.424072	0.4979702
Albumin	2.661433	2.6972510
S. creatinine	1.217757	1.221130
S. bilirubin	3.96598	3.672510
S. sodium	129.89	129.53
Age	53.63	54.14
INR	1.8400	1.810990
CTP	10.96	10.91
MELD	19.53	19.16
MELD-Na	23.72	23.59
I-MELD	5.0290	5.17772
MEOS	1.51300	1.488686
UKELD	60.35	60.36
Portal vein diameter	13.14611	13.34971

Table 3 Quantitative baseline variables in predicting 3-month mortality

Variable	*p*-value	Lower	Upper
Hemoglobin	.001	0.2616569	1.0561001
AGE	0.148	−4.424	0.667
Total count	0.276	−1202.203	4195.680
Platelet count	.045	−2.3285508E3	−26.3672900
Eosinophil count	0.545	−29.328	55.459
Albumin	.030	.0121859	0.2337954
Creatinine	.000	−0.5146837	−0.2456901
Bilirubin	.000	−3.3209825	−1.6175222
Sodium	.014	0.314	2.770
INR	.000	−0.4865465	−0.2667245
Portal vein diameter	.002	−1.1167817	−0.2645267
Liver span	.069	−.0278204	0.7511848
Spleen span	.000	−1.2908248	−0.5521658

Among the qualitative variables analyzed by chi-square test, hepatic encephalopathy and ascites were significant in predicting 3-month mortality (Table 4).

AUROC was plotted in comparing CTP, MELD, and MELD variants in predicting 3-month mortality. In predicting 3-month mortality, the AUROC of CTP was 0.769; Child was (as our study was on DCLD, only Child B and C were taken) 0.659; MELD was 0.727; MELD-Na

Table 4 Qualitative variables in predicting 3-month mortality

	Ascites	HE
Chi-square	3.787a	2.391b
df	2	3
Asymp. sig.	.000	.000

was 0.735; I-MELD was 0.723; MESO was 0.727; and UKLED was 0.686 (Table 5 and Fig. 2).

CTP had maximum AUROC in predicting 3-month mortality (0.767, cutoff of > 11 with sensitivity of 71% and specificity of 73.8%) followed by MELD-Na (0.735, cutoff of > 25 with sensitivity of 65% and specificity of 72%).

Table 5 AUROC of various predictor model in predicting 3-month mortality

Test result variable(s)	Area under the curve
CTP	0.767
Child	0.659
MELD	0.727
MELD-Na	0.735
i-MELD	0.723
MEOS	0.727
UKELD	0.686

Logistic regression analysis of significant variables was done, and new score (CHIBA score) was proposed (Table 6).

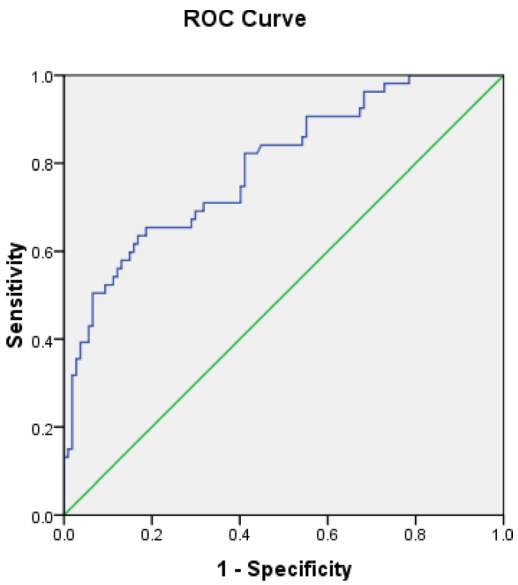
CHIBA score = creatinine × 0.6 + HE × 0.4 + INR × 0.8 + bilirubin × 0.125 + ascites × 1.2. C stands for creatinine, H for hepatic encephalopathy, I for INR, B for bilirubin, and A for ascites. Ascites was further divided into absent or mild with a score of 0, moderate −1, and tense 2. Hepatic encephalopathy is absent with score of 0, grade 1 West Haven score of 1, grade 2 score of 2, and grades 3 and 4 a score of 3.

It had AUROC of 0.793 (at a cutoff of ≥ 5.5, it has sensitivity of 66% and specificity of 76) (Fig. 2).

Validation of new score

The sample size for the validation cohort was calculated by the formula 4PQ/D2/prevalence.

P is sensitivity, *Q* is 1-P, and *D* is 20% of P. Death at 3 months was 33%. The sample size was calculated to be 156. For validation, 214 patients were taken, and the baseline characteristics of the validation cohort are shown in Table 2. It was comparable to the test cohort. AUROC of



Area	Std. Error[a]	Asymptotic Sig.[b]
0.793	0.27	0.000

Fig. 2 AUROC of new score

Table 6 New score (CHIBA score) proposed

	B	SE	Wald	df	Sig.	Exp(B)
Hb	−0.198	.092	4.650	1	.031	0.820
PLT	.000	.000	0.109	1	0.741	1.000
Albumin	−.050	0.315	.025	1	0.874	0.951
Creatinine	0.592	0.237	6.236	1	.013	1.807
Bilirubin	0.126	.045	7.998	1	.005	1.135
NA	.033	.030	1.206	1	0.272	1.034
INR	0.795	0.369	4.643	1	.031	2.214
Portal	.048	.095	0.261	1	0.609	1.050
Spleen	0.153	0.115	1.751	1	0.186	1.165
HE	0.403	0.132	9.309	1	.002	1.496
Ascites	1.190	0.404	8.695	1	.003	3.287
Constant	−11.070	4.696	5.557	1	.018	.000

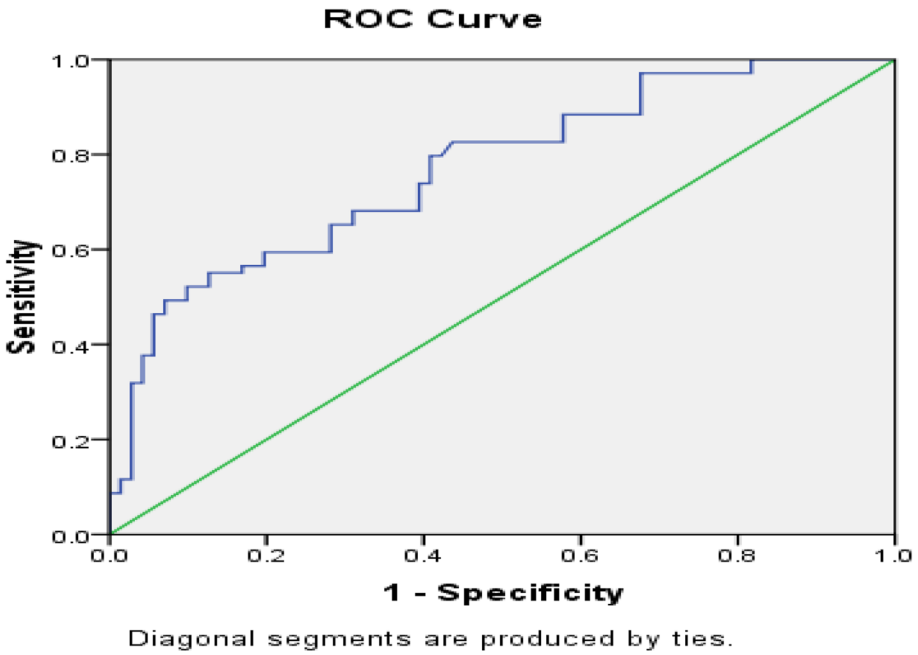


Fig. 3 AUROC of validation cohort

Table 7 AUROC of test and validation cohort

	AUROC
Test cohort	**0.793**
Validation cohort	**0.77**

CHIBA score in the validation cohort was 0.77. At a cut-off of > 5.5, it has a sensitivity of 60% and specificity of 77% (Fig. 3, Table 7).

Discussion

There is need for precise prognostic indicators for survival of DCLD patients which is important to guide clinical decision. The MELD score has been used as a prognostic tool for patients with DCLD and found to be beneficial in predicting 3- and 12-month survival of DCLD patients. However, MELD score has shown less prognostic accuracy as compared with the CTP score [11]. Though there are comparison studies between CTP, MELD, and MELD variants even in the Indian population, a study comparing almost every validated MELD

variants, MELD, and CTP are very few in the literature. Another aim of this study was to propose a new score that can predict mortality better than the existing models in the Indian population.

Data from our study showed that the presence of ascites and hepatic encephalopathy was significant in predicting 3-month mortality. Hepatic encephalopathy, which denotes excessive portosystemic shunting, was also a significant factor of 3-month mortality in our study which is comparable to previous studies [12, 13].

CTP had maximum AUROC in predicting 3-month mortality (0.767, cutoff of > 11 with a sensitivity of 71% and specificity of 73.8%) followed by MELD-Na (0.735, cutoff of > 25 with a sensitivity of 65% and specificity of 72%). CTP was found to have an important prognostic factor for DCLD patients [14–16], and hence, CTP score with many subjective components is still a very important prognostic marker in DCLD which is proved by our study. Our results confirmed that the predictive power of the standard MELD can be augmented by addition of sodium, as demonstrated higher AUCs for MELD-Na, MESO index, and I-MELD which are in agreement with the study by Biselli et al. [17]. The problem with MELD score is that it has logarithmic variables, and its calculation is not possible at the bedside. Variants like MESO and I-MELD were derived from MELD which makes these scores unsuitable for bedside calculations. CHIBA score is simple, and its derivation involves only simple calculation, and hence, it is easy to calculate CHIBA score at bedside. Moreover, CHIBA score has ascites and hepatic encephalopathy as its components. One of the drawbacks of the MELD is that it is not able to predict mortality accurately in those with ascites, and this was partially overcome with the advent of MELD-Na. Ascites and hepatic encephalopathy likely to increase the predictive power of CHIBA over MELD, and MELD variants as later were shown to be less effective in these situations. Besides, although iMELD had the highest AUC by incorporating age and Na to raise their prognostic ability, it did not reveal significant superiority to other MELD-based systems.

New CHIBA score has an AUROC of 0.793 (at a cutoff of > 5.5, sensitivity 66%, and specificity 76%) better than all other predictor models. A study by Zou et al. [18] evaluated the inhospital mortality in relation to ALBI, CTP, and MELD scores in 631 cirrhotic patients and found that the albumin-bilirubin (ALBI) score had the best AUC (0.808, 0.785, 0.787, respectively). The new CHIBA score was validated in an external cohort with a sample size of 214. AUROC of CHIBA score in the validation cohort was 0.77 which is better than previous studies [19, 20]. At a cutoff of > 5.5, it has a sensitivity of 60% and specificity of 77% in predicting 3-month mortality. Our results showed excellent reproducibility, suggesting that new CHIBA score is generalizable to patients with similar conditions from different regions. The CHIBA score can be easily calculated from routine physical examination and laboratory testing and is thus available even in lower resource settings. Although the study results were encouraging, this study still had potential limitations. As this study is a retrospective study, further refinement should be pursued to validate this score by prospective studies.

Conclusion

CHIBA score is superior to MELD and MELD variants in predicting 3-month mortality, and it is validated in an external cohort. It can be calculated at the bedside and does not require mobile applications as it is a simple score with no logarithmic variables and better than all existing prognostic models for DCLD.

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None.

Authors' contributions
Dr. SA, first and corresponding author; made substantial contributions to the conception and design of the work, acquisition, analysis, and interpretation of data; and also have drafted the work after revising it. Dr. JV, co-author and helped in analysis of results and data collection. The author(s) read and approved the final manuscript.

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Availability of data and materials
Yes

Declarations

Ethics approval and consent to participate
The study was approved by the Institutional Ethics Review Board of the Hospital, and informed written consent was provided by all patients.

Consent for publication
Given by all authors

Competing interests
The authors declare that they have no competing interests.

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