Annals of Clinical and Medical Case Reports

Research Article

ISSN 2639-8109 | Volume 13

Advancing Mortality Prediction in Critical Care for Cirrhosis Patients: A Novel Approach

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Received: 01 July 2024
Accepted: 15 July 2024
Published: 22 July 2024
J Short Name: ACMCR

Keywords:

Cirrhosis; Mortality; Critical Care; Quantitative risk scores

Citation:

Touray M, Advancing Mortality Prediction in Critical Care for Cirrhosis Patients: A Novel Approach. Ann Clin Med Case Rep. 2024; V13(21): 1-10

1. Abstract

1.1. Background and Objectives: Cirrhosis, a chronic liver condition stemming from various causes, poses substantial healthcare challenges. Predicting patient outcomes is critical for effective management, particularly in intensive care settings. This study explores a novel approach, integrating advanced data analysis techniques and clinical information, to enhance mortality prediction accuracy for cirrhosis patients in critical care, aiming to empower healthcare professionals with more precise prognostic insights. The objective of this investigation is to introduce an innovative approach capable of early and precise prediction of 30-day hospital mortality in individuals diagnosed with cirrhosis.

1.2. Method: For this study, we carefully curated a cohort of 1,783 cirrhosis patients who were admitted to critical care units within the 2011-2012 timeframe, utilizing the extensive MIMIC III repository. We undertook a retrospective evaluation of potential predictive factors linked to 30-day hospital mortality. Employing Classification and Regression Tree (CART) analysis, we devised a novel clinical scoring system specifically tailored for early mortality prediction among cirrhosis patients. Furthermore, we leveraged the receiver-operating characteristic (ROC) curve to calculate the area under the ROC curve (AUC), an established metric for assessing predictive model performance.

1.3. Results: Our innovative PWBC (prothrombin time, white blood cell, total bilirubin, and creatinine) scoring system encompassing criteria such as prothrombin time > 2.265 seconds, serum white blood cell count > 8.88K/uL, serum creatinine > 1.535 mg/dL, and serum total bilirubin ≤ 8.0 mg/dL, emerged as a robust and independent predictor of hospital mortality among cirrhosis patients. In our validation dataset, the newly introduced scoring system achieved an AUC of 0.83, demonstrating similar performance to the UKELD score (AUC 0.83), while surpassing the MELD score (AUC 0.82) and MELD-Na score (AUC 0.71).

1.4. Conclusion: Our pioneering PWBC scoring system presents a highly efficient, accurate, and objective tool for early hospital mortality prognosis in cirrhosis patients, contributing to improved patient care and treatment decisions.

2. Introduction

Cirrhosis of the liver signifies the advanced stage of fibrotic transformations within the liver tissue, arising from persistent damage. This late-phase liver condition is typically irreversible, with liver transplantation serving as the primary treatment. However, the scarcity of available organ grafts from deceased donors has spurred the necessity for both precise risk assessment and equitable allocation strategies. The distribution of liver transplants in most regions hinges on the severity of the disease, as determined by the model

of end-stage liver disease (MELD) [1-3]. The model for end-stage liver disease (MELD) serves as a widely recognized prognostic tool for individuals with cirrhosis. The MELD score computes the 3-month mortality risk for patients based on specific laboratory measurements, including bilirubin, creatinine, and the international normalized ratio (INR). The MELD score has been validated for assessing mortality risk in patients awaiting liver transplants. It is crucial to acknowledge that the MELD score can be influenced by discrepancies in laboratory methodologies for creatinine and INR [4, 5]. Beyond its role in donor liver allocation, MELD has received validation as a predictive score across various cohorts. For instance, it's been used to forecast short-term mortality in cirrhosis patients undergoing elective and emergency surgeries [6], as well as in cases of alcohol-related hepatitis [7]. Recognizing the substantial impact of sodium levels on the liver cirrhosis risk [2, 3], an extended MELD-Na score has incorporated sodium levels as an additional influential variable. An extensively adopted refinement of MELD takes the form of the model for end-stage liver disease sodium (MELD-Na). Hyponatremia, a condition arising from imbalanced fluid retention relative to sodium levels [8], has emerged as a key factor associated with poorer prognoses among cirrhosis patients [9, 10]. The integration of serum sodium concentration into the model alongside the original MELD components has highlighted enhanced predictive capabilities for 90-day mortality among patients awaiting liver transplants, both within the United States [11] and across Europe [12]. While hyponatremia often surfaces notably in cirrhosis patients [9], the comprehensive assessment and direct comparison of MELD-Na's prognostic efficacy in this subset, relative to MELD alone, remains a subject requiring broader investigation. In 2008, a novel scoring framework emerged, aimed at refining the process of selecting chronic liver disease patients for liver transplantation (LTx) on a national scale [13]. The inception of the United Kingdom MELD (UKELD) score hinged on essential serum markers such as sodium, creatinine, bilirubin, and INR. This novel construct emerged from a comprehensive analysis involving 1103 patients, with subsequent validation conducted on an independent, prospective cohort of 452 individuals [14]. Presently, there is a scarcity of studies that have systematically assessed the predictive accuracy of different quantitative risk scoring methods among cirrhosis patients. The findings have been inconsistent [15, 16], both in terms of whether MELD independently predicts mortality through multivariate analysis or its performance in discerning ability using receiver operator characteristic (ROC) curves. This study aims to enhance the accuracy of mortality prediction for individuals with cirrhosis. Specifically, we are introducing a new scoring method based on PWBC (prothrombin time, white blood cell, total bilirubin, and creatinine) as a predictive factor. By constructing a comprehensive model, our aim is to effectively forecast the likelihood of 30-day mortality in patients with cirrhosis who are in critical care settings. Through this innovative method, we aspire to contribute to the field of medical research by refining mortality prediction tools for cirrhosis patients and ultimately improving their clinical outcomes.

3. Materials and Method

We conducted a study on 1,783 consecutive patients with cirrhosis who received critical care in the Medical Information Mart for Intensive Care (MIMIC) repositories. MIMIC databases provide extensive and anonymized health-related information on critical care patients from the Beth Israel Deaconess Medical Center in Boston, USA [17]. The diagnostic criteria for cirrhosis were based on the International Classification of Diseases, 9th Revision, "5712", "5715". We exclude patients who were not admitted to critical care and features with missing data exceeding 30% were removed. Detailed clinical data, including demographics, comorbidities, laboratory values, and physical examination findings, were collected upon admission to the critical care unit, these features were used for multivariate analysis and model development. We conducted a thorough review of the conventional variables for all 1,783 patients after hospitalization in critical care. The early prediction was defined as predicting hospital mortality within 30 days after admission to critical care. Patients were classified into two groups: survivors (n = 1,371) and non-survivors (n = 412) to explore variables influencing mortality.

4. Ethics

Upon obtaining data access through the prescribed procedures, we adhered to the ethical guidelines set by PhysioNet Clinical Databases, including completing the mandatory online human research ethics training (Certification Number: 55140935). The study was conducted in compliance with the principles outlined in the Declaration of Helsinki.

5. Statistical Analysis

The normally distributed data were analyzed using Student's t-tests, and the results were presented as mean ± standard deviation (SD). For non-normally distributed variables, the Mann Whitney U test was employed, and the data was presented as a median (quartile range). Categorical data were analyzed using Fisher's exact test. To determine the variables influencing hospital mortality, a multivariate analysis was conducted through multiple logistic regression. Additionally, a new scoring system was developed using Classification and Regression Tree (CART) analysis. The accuracy of this novel clinical prediction scoring system was evaluated using receiver-operating characteristic (ROC) curves. The utility of the scoring system was quantified by the area under the curve (AUC). Statistical significance was defined as a two-tailed P-value less than 0.05. All statistical analyses were performed using R version 4.3.0 (2023-04-21) and SPSS, ensuring comprehensive and reliable data assessment.

6. Results

This study comprises a cohort of 1,783 individuals diagnosed with cirrhosis. Among them, 412 participants belong to the non-survivor group, while the control group comprises 1,371 survivors. The cohort includes 1,219 males and 564 females, with an average age of 57.8 years (ranging from 21 to 88 years). The overall hospital mortality rate was 412(23%), with 270 male patients (66%) and 142 female patients (43%) succumbing to the condition.

6.1. Characteristics of Survivors and Non-Survivors on Admission

As depicted in (Table 1), non-survivors exhibited higher levels of serum creatinine, serum white blood cell count, ALP, ALT, AST, serum total bilirubin, magnesium, albumin, and prothrombin time compared to survivors. Significant differences were observed across several variables, including age, albumin, total bilirubin, ALT, AST, magnesium, prothrombin time, creatinine, sodium, and white blood cell count ($P < 0.05$). Notably, platelet levels and serum hematocrit measurements were found to be lower in non-survivors, with statistical differences of 0.000 and 0.282, respectively. Furthermore, non-survivors tended to be older, with a significant difference ($P < 0.05$). However, there were no discernible gender-based differences ($P > 0.05$).

6.2. Multivariate analysis for variables within 24 h after admission to critical care

The utilization of multivariate analysis through stepwise forward selection and backward elimination logistic regression (Table 2) revealed distinct predictors of hospital mortality. Serum creatinine, serum white blood cell count, serum bilirubin, and prothrombin time emerged as independent prognostic factors. Notably, each unit increase in prothrombin time was linked to a 3.151-fold increase in-hospital mortality risk. Similarly, a higher serum white blood cell count exhibited a significant association with a 1.124-fold increase in mortality risk. Additionally, serum bilirubin and creatinine levels were identified as risk factors contributing to the prediction of hospital mortality, with odds ratios of 1.044 and 1.312 respectively.

Table 1: Baseline characteristics of cirrhosis and no cirrhosis patients in the emergency department

Variables	Survivor (n = 1,371)	Non survivor (n = 412)	p value
Age, median (min– max)	56 (21 – 88)	57 (25 – 88)	0.000*
Gender (Male) n (%)	949 (69)	270 (66)	0.988
Albumin (g/dL)	2.9 (2.6 – 3.3)	2.7 (2.3 – 3.1)	0.000*
Total bilirubin (mg/dL)	2.2 (1.15 – 4.27)	7.7 (2.6 – 18.3)	0.000*
ALP (IU/L)	108.38 (80.8 – 148.4)	111.7 (85.1 – 172.1)	0.243
ALT (IU/L)	40.4 (23.0 – 79.3)	47.9 (28.1 – 103)	0.000*
AST (IU/L)	71 (42.5 – 124.9)	106.4 (59.4 – 208.6)	0.000*
Potassium (mEq/L)	4 (3.77 – 4.27)	4.1 (3.8 – 4.5)	0.000*
Magnesium (mEq/L)	1.92 (1.77 – 2.07)	2.12 (1.9 – 2.3)	0.000*
Sodium (mEq/L)	137.6 (135 – 139.8)	137.7 (133.3 – 141.5)	0.000*
Platelet count (K/uL)	107.9 (78 – 169.2)	92.6 (61.8 – 136.2)	0.000*
Hematocrit	29.7 (27.6 – 32.2)	28.9 (26.6 – 31.6)	0.282
Creatinine (mg/dL)	0.9 (0.75 – 1.47)	1.0 (1.1 – 2.9)	0.012*
White blood cell (K/uL)	7.64 (5.5 – 10.6)	24 (8.3 – 16.1)	0.000*
Prothrombin time	1.5 (1.32 – 1.79)	13 (1.7 – 2.7)	0.000*

AST: Aspartate Aminotransferase ALP, Alkaline Phosphatase; ALT, Alanine Aminotransferase; mg/dL, Milligrams per Deciliter; g/dL, Grams per Deciliter; s, sections; IU/L, International units per litre; mEq/L,milli equivalents per litre. *indicates the variable is significant

Table 2: Multivariate analysis of factors for in-hospital mortality of cirrhosis patients.

Parameter	β	SE (β)	Wald $\chi 2$	P-value	OR	95% CI of OR
Prothrombin time (seconds)	1.147	0.823	1.942	0.002*	3.151	0.91–3.39
White blood cell (K/uL)	0.117	0.816	0.02	0.037*	1.124	0.09–1.17
Total bilirubin (mg/dL)	0.043	0.72	0.003	0.043*	1.044	0.02–1.12
Creatinine (mg/dL)	0.272	0.746	0.132	0.014*	1.312	0.18–1.36

OR odd ratios; SE, standard error; CI, confident interval, *means the variable is statistically significant.

6.3. Classification and Regression Tree Analysis

In the process of Classification and Regression Tree (CART) analysis, we employed the methodology of classification and regression tree modelling. This involved partitioning patients into nodes based on cutoff points derived from classification variables. The Gini index was utilized as the criterion for branching decisions during the tree construction. To address the issue of missing data, instances with missing values lower than 30% were imputed prior to the tree development phase.

Our focus was on identifying key variables that effectively stratify patients according to the risk of mortality. Through CART analysis, we pinpointed four essential variables - prothrombin time, serum white blood cell count, serum total bilirubin, and serum creatinine (PWBC). The resulting CART tree is visually represented in (Figure 1). Among these variables, prothrombin time emerged as a pivotal predictor of hospital mortality. Serum white blood cell count exhibited the capability to distinguish high-risk and low-risk cases. Further differentiation of intermediate-risk patients was accomplished through the use of serum total bilirubin and creatinine levels at the final stage of analysis. At each decision point within the tree, patients were categorized into distinct groups based on classification criteria. Illustrated in (Figure 1), when prothrombin time surpassed 2.265, the associated probability of hospital mortality reached 62%. Intriguingly, this probability elevated to 74.3% when prothrombin time exceeded 2.265 and serum white blood cell count exceeded 8.88K/uL. Subsequently, with the added condition of serum creatinine exceeding 1.535 mg/dL, the probability of mortality further increased to 88.5%. Conversely, when prothrombin time was 2.265 or lower, serum white blood cell count was 12.77 K/uL or lower, and serum total bilirubin was 7.62 mg/dL or lower, the probability of hospital mortality diminished to 8%. Utilizing the four variables identified by CART analysis, a novel scoring system was devised. Each variable was assigned one point, resulting in a cumulative 4-point score. The criteria for point assignment within the first 24 hours of admission included Prothrombin time > 2.265 seconds, serum white blood cell count > 8.88K/uL, serum creatinine > 1.535 mg/dL, and serum total bilirubin less than or equal to 8.0 mg/dL. Upon calculating scores for the entire cohort of 1,783 patients, the area under the curve (AUC) for the PWBC score was determined to be 0.83.

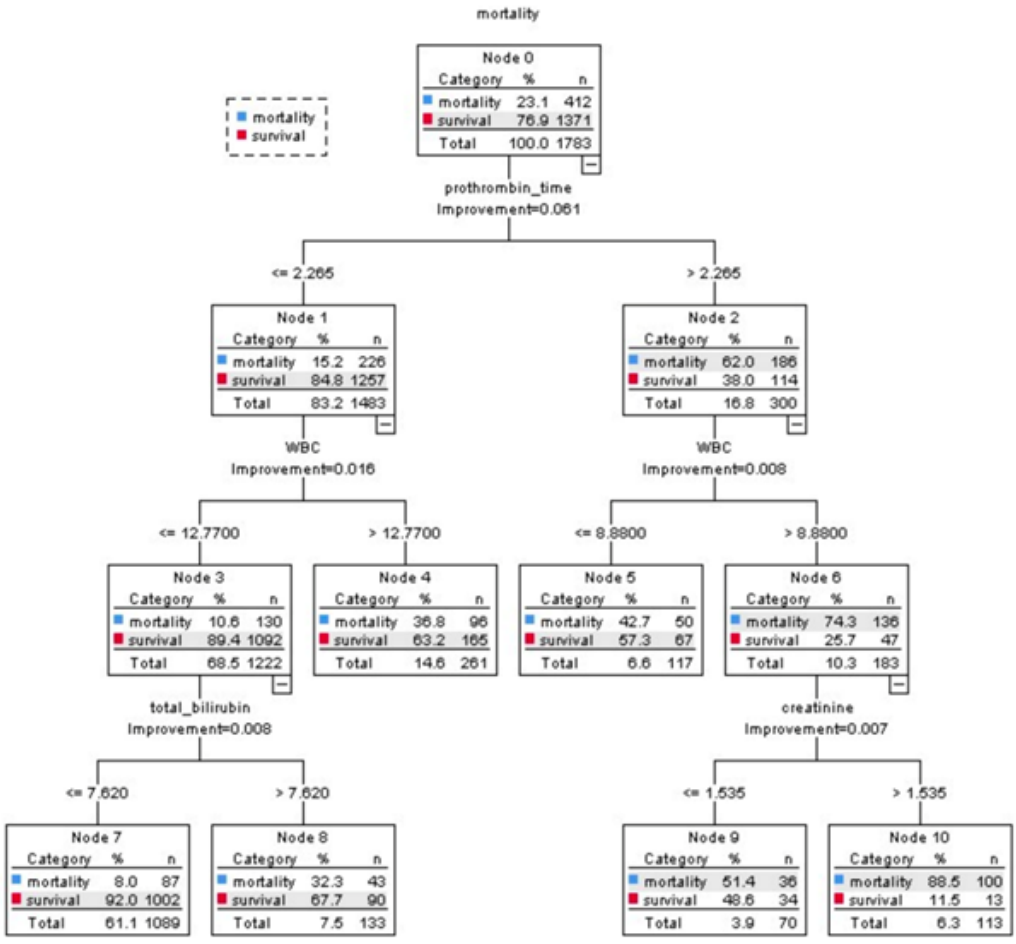

Figure 1: Classification and regression tree analysis of risk factors for mortality in 1,783 cases

6.4. The ROC curve analysis among 5 score systems within 24 hours after admission

We conducted a comparative analysis of the newly proposed clinical scoring system against the MELD, MELD-Na, and UKELD scores to assess their accuracy in predicting hospital mortality. Receiver operating characteristic (ROC) curves were utilized for this comparison, as depicted in (Figure 2). The AUC for the PWBC score was 0.83, while the UKELD score achieved an AUC of 0.83, the MELD score had an AUC of 0.82, and the MELD-Na score demonstrated an AUC of 0.71. These findings suggest that the novel PWBC model showed similar predictive performance to the UKELD score in terms of hospital mortality, with a notably high AUC value. It was observed that the MELD score and MELD-Na score had comparatively lower prognostic values for mortality prediction in our study. The specific AUC values for each scoring system are detailed in (Table 3).

6.5. Comparing our newly scoring system with Albumin

In our study, we compared the predictive performance of our novel PWBC scoring system with that of the albumin biomarker. The AUC values obtained demonstrate a notable contrast between the two variables, with the PWBC scoring system exhibiting a significantly higher AUC (0.83) compared to albumin (0.61) (Table 4).

6.6. Preexisting diseases among cirrhosis patients

In our investigation, we conducted a comprehensive analysis of the influence of various comorbidities on cirrhosis patients, as detailed in (Table 5). Comorbidities in cirrhosis were defined as pre-existing medical conditions for which patients were actively receiving medical care or treatment at the time of hospital admission, preceding the onset of severe complications of cirrhosis. These comorbidities encompassed conditions such as encephalopathy, portal hypertension, ascites, hepatitis B, diabetes, chronic kidney disease, obesity, varices, atrial fibrillation, and hepatocellular carcinoma, each contributing significantly to the clinical landscape. Through examining their prevalence and interactions, our aim was to enrich our understanding of their collective impact on the mortality risk of cirrhosis patients, thereby informing more targeted and effective healthcare interventions Table 5.

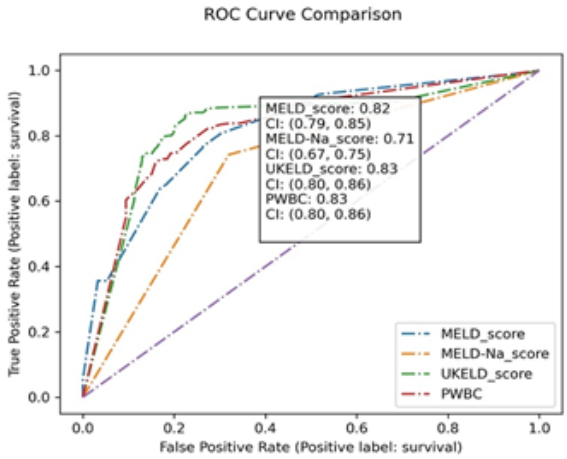

Figure 2: The ROC curve analysis among 5 score systems

Table 3: Comparison of area under the ROC between 5 scoring systems.

Score system	AUC	P-value	95% Confident Interval
PWBC (our novel) score	0.83	0.01	0.80 – 0.86
MELD score	0.82	0.05	0.79 – 0.85
MELD-Na score	0.71	0.07	0.67 – 0.75
UKELD score	0.83	0.01	0.80 – 0.86

The PWBC score (Prothrombin time, white blood cell, total bilirubin, and creatinine), MELD score (Model for End-Stage Liver Disease), MELD-Na score (Model for End-Stage Liver Disease-Sodium), UKELD Score (United Kingdom Model for End-Stage Liver Disease), AUC area under the curve.

Table 4: Comparing our PWBC (novel score) to Albumin

	AUC	95% Confident Interval
PWBC (our novel) score	0.83	0.80 – 0.86
Albumin	0.61	0.48 – 0.73

Table 5: Comparison of the comorbidities of the patient in two groups.

Comorbidities	Survivor (n = 1,371)	No survivor (n = 412)	P-value
Encephalopathy n (%)	99 (7%)	32 (7%)	0.697
Portal Hypertension n (%)	169 (12%)	103 (25%)	0.000*
Ascites n (%)	213 (15%)	55 (13%)	0.184
Hepatitis B. n (%)	114 (8%)	27 (6%)	0.053*
Diabetes n (%)	378 (27%)	90 (21%)	0.026*
Chronic Kidney Disease n (%)	303 (17%)	63 (15%)	0.039*
Obesity n (%)	90 (6%)	21 (5%)	0.204
Varices n (%)	323 (23%)	55 (13%)	0.000*
Atrial Fibrillation n (%)	236 (17%)	91 (22%)	0.008*
Hepatocellular Carcinoma n (%)	211 (15%)	43 (10%)	0.07

*Indicates the variable is significant

6.7. Variable Importance

In our analysis, we conducted a thorough assessment of variable importance to uncover the factors that exert the most significant influence on cirrhosis patient outcomes. Notably, our findings revealed that prothrombin time emerged as the most crucial variable, underscoring its pivotal role in predicting mortality. Total bilirubin, magnesium, white blood cell count, AST levels, and creatinine levels also demonstrated notable importance in shaping the overall risk profile. This comprehensive understanding of variable importance enhances our ability to pinpoint the key determinants of cirrhosis outcomes, guiding clinicians towards more effective risk assessment and targeted interventions (Figure 3).

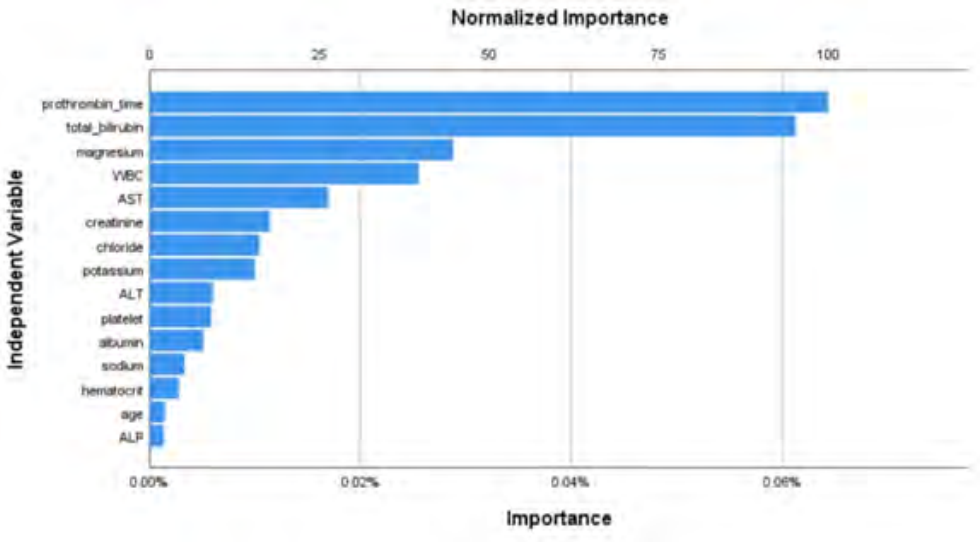

Figure 3: Variable Importance

7. Discussion

Cirrhosis stands as a significant contributor to morbidity and mortality within the realm of chronic liver diseases [18]. This condition carries the potential to escalate into hepatocellular carcinoma (HCC) and hepatic decompensation, involving manifestations such as ascites, hepatic encephalopathy, and variceal bleeding [18-21]. On a global scale, it accounted for 2.4% of total deaths in 2019, underscoring its impact [22]. Accurate assessments of the global burden of cirrhosis and the attributions of various liver disease causes hold immense significance for medical professionals, researchers, and healthcare policymakers. These insights inform clinical strategies, steer research efforts, and facilitate resource allocation. The early, precise prognosis of severe adverse events like critical medical complications or mortality is pivotal in averting unnecessary fatalities. In light of our investigation, we pinpointed prothrombin time, serum white blood cell count, serum total bilirubin, and serum creatinine (PWBC) as key independent predictors that intimately correlated with hospital mortality in cirrhosis. These factors all emerged as risk indicators (with OR > 1) about prognosticating adverse outcomes. The measurement of prothrombin time has emerged as a pivotal factor in predicting mortality among patients with cirrhosis. Research studies have consistently highlighted the association between coagulation disorders and prolonged prothrombin time (PT) in individuals with

chronic liver diseases. A previous study demonstrated that patients admitted with liver cirrhosis or chronic liver diseases often experience coagulation abnormalities, leading to significantly prolonged prothrombin time (PT) and an elevated international normalized ratio (INR) [23], ultimately contributing to mortality. Another inquiry revealed a notable threshold of prothrombin time at 1.6 or 1.7, indicating the onset of coagulation dysfunction and subsequently higher mortality rates in cirrhosis and advanced fibrosis patients, respectively. Additionally, an observed 28-day mortality rate of 15% was linked to a prothrombin value of 2.1, shared by both cirrhosis and advanced fibrosis patient groups [24]. In clinical practice, the measurement of circulating white blood cell (WBC) count holds significant value as a prominent marker of systemic inflammation. The extensive utilization of WBC counts as an indicator is evident due to its wide availability. A multitude of investigations have established a positive correlation between elevated WBC counts and mortality rates among individuals with cirrhosis [25-27]. This body of research has predominantly originated from high-income countries across Asia [27, 28] as well as Western regions [29, 30]. Similar to our findings, the heightened importance of elevated WBC counts in predicting mortality among cirrhosis patients is further accentuated by studies conducted in African contexts, including countries like Egypt and Ivory Coast [31, 32].

Elevated concentrations of creatinine, a crucial renal function marker, have arisen as a substantial predictor of mortality risk among individuals with cirrhosis. Our study's results echoed those in previous research [26], demonstrating parallel findings. Specifically, a serum creatinine level ≥ 2.0 mg/dL was identified as a potential predictor of in-hospital mortality in patients with liver cirrhosis. [33]. Elevated concentrations of total bilirubin, a crucial marker indicative of liver function, have been identified as a significant predictor of mortality risk among individuals with cirrhosis. Our study's findings are consistent with previous investigations [33], which revealed a link between heightened total bilirubin levels and an elevated probability of in-hospital mortality in liver cirrhosis patients. Among patients with a serum total bilirubin level ≥ 2 mg/dL, the hospital mortality rate stood at 31.9%, while for those with a serum total bilirubin level < 2 mg/dL, it was 17.0% ($P < 0.001$) [34]. Higher total bilirubin concentrations exhibited a positive association with an escalated risk of all-cause mortality [hazard ratio (HR) 1.59, 95% confidence interval (CI) 1.46–1.72; $p < 0.001$] [24]. Utilizing CART analysis to assess the risk of hospital mortality, we pinpointed four established variables that effectively stratify patients. These variables were subsequently incorporated into our newly devised scoring system, PWBC. Timely intervention is pivotal in the early stages of cirrhosis, necessitating accurate risk stratification. The introduced PWBC scoring model enables us to categorize patients into distinct hospital mortality risk groups within the initial 24 hours of hospitalization.

The swift and straightforward determination of all four parameters within the first 24 hours of admission is crucial for both diagnosis and subsequent treatment planning for cirrhosis patients during their hospital stay. Consequently, this novel severity assessment tool, the PWBC scoring system, holds promise for early stratification and proves to be a valuable prognostic tool in predicting mortality among cirrhosis patients. Additionally, we conducted a comparison of the four scoring systems: PWBC, UKELD, MELD score, and MELD-Na, using ROC analysis to determine their accuracy in predicting hospital mortality. In the management of cirrhosis, having an accurate assessment of severity is crucial from the beginning. An ideal scoring system should be quick, effective, precise, and not influenced by treatments. This task is quite complex and involves both clinical judgment and careful patient monitoring [35]. It's important to highlight that the PWBC scoring system presented in our study is not influenced by treatments and can accurately predict the disease's progression at an early stage. Each parameter included can be easily measured during the initial stages of a hospital stay, typically within the first 24 hours of admission, without requiring additional interventions or complex calculations. Furthermore, it is noteworthy that albumin, a key biomarker for assessing cirrhosis severity, was not incorporated into the selected scoring variables. The decision to not include albumin from the PWBC scoring system was reached following a comprehensive evaluation of several factors. These considerations encompassed an in-depth statistical analysis conducted within our cohort, prioritization of model simplicity, and assessment of the predictive efficacy of other variables included in the model. While recognizing the undeniable significance of albumin in the landscape of liver disease, our meticulous analysis revealed that the PWBC combination, comprising prothrombin time, white blood cell count, total bilirubin, and creatinine, exhibited robust predictive capability for hospital mortality among cirrhosis patients. Our findings suggest that these selected variables collectively offer a robust framework for mortality prediction in cirrhosis patients, effectively complementing clinical decision-making processes.

In addition, we compared our newly proposed PWBC scoring system with albumin levels as predictors of mortality among cirrhosis patients. Our findings reveal a significant difference in the AUC values, with our PWBC scoring system demonstrating superior predictive performance (AUC = 0.83) compared to albumin levels (AUC = 0.61). While albumin is widely recognized as a marker for liver function and nutritional status, its predictive capacity is notably limited when used alone. In contrast, our PWBC scoring system integrates multiple critical variables, including prothrombin time, white blood cell count, total bilirubin, and creatinine, providing a comprehensive assessment of physiological and pathological indicators. This comprehensive approach enhances prognostic accuracy, highlighting the potential clinical utility and superiority of our novel scoring system over conventional markers like albumin.

8. Clinical application of our new model (PWBC)

The innovative PWBC (prothrombin time, white blood cell, total bilirubin, and creatinine) scoring system we've developed appears to have substantial clinical utility in the context of critical care for cirrhosis patients. By incorporating key parameters such as prothrombin time, white blood cell count, serum creatinine, and serum total bilirubin, our model serves as an efficient tool for predicting hospital mortality among cirrhosis patients.

The significance of this model lies in its ability to offer a tailored and precise prediction of mortality risk. With its robust performance as an independent predictor, the PWBC scoring system aids healthcare practitioners in identifying patients at higher risk of adverse outcomes. This can facilitate more timely and targeted interventions, enabling medical teams to allocate resources effectively, optimize treatment strategies, and potentially improve patient survival rates. Furthermore, the model's simplicity, comprising readily available clinical parameters, enhances its feasibility for practical implementation in critical care settings. This user-friendly approach aligns with the real-world demands of healthcare professionals and reinforces its potential to contribute to enhanced patient care. Overall, the PWBC scoring system presents a valuable advancement in the field of mortality prediction for cirrhosis patients in critical care. It holds the promise of positively impacting clinical decision-making, patient outcomes, and resource allocation, underscoring its usefulness in improving the quality of care provided to this vulnerable patient population.

9. Study Limitation

While our study provides valuable insights into mortality prediction for cirrhosis patients in critical care, it is important to acknowledge certain inherent limitations. Firstly, the retrospective design of the study may have introduced biases and confounding variables during data collection and analysis. Although efforts were made to mitigate these potential sources of bias, the retrospective nature of the study necessitates cautious interpretation of the results. Secondly, it would be beneficial to investigate other adverse outcomes beyond mortality, such as multiple organ failure, length of hospital and ICU stays, and duration of mechanical ventilation. This would offer a more comprehensive picture of the risks associated with cirrhosis. Moreover, our study underscores the need for future prospective validation to confirm the predictive accuracy of the PWBC scoring system in real-time clinical settings. Prospective studies offer the opportunity to collect data in a controlled manner, minimizing biases and providing more robust evidence of the scoring system's effectiveness. Therefore, while our findings contribute to the understanding of mortality prediction in cirrhosis patients, further research involving prospective validation is warranted to enhance the reliability and generalizability of our results. Despite these limitations, we are confident that our data contributes valuable and reliable insights to the field of cirrhosis research.

10. Future studies

In our forthcoming studies, we aim to conduct a comprehensive assessment of how COVID-19 infection influences the prognosis and clinical outcomes of individuals with cirrhosis. This entails investigating the impact of COVID-19 on mortality risk, disease progression, liver function, and overall clinical management within this patient population. Our research represents a concerted effort to bridge critical gaps in understanding the intersection of COVID-19 infection and cirrhosis. By delving into these aspects, we seek to enhance clinical care, optimize treatment strategies, and ultimately improve patient outcomes in this vulnerable population."

11. Conclusion

Concluding this investigation, we have delineated a novel scoring system (PWBC) comprising the following criteria: Prothrombin time > 2.265 seconds, serum white blood cell count > 8.88K/uL, serum creatinine > 1.535 mg/dL, and serum total bilirubin less than or equal to 8.0 mg/dL. Each factor contributes one point towards the prediction of mortality, with prothrombin time emerging as the most impactful predictor. PWBC stands as an objective, efficient, and accurate approach, exhibiting similarity to the UKELD score while outperforming the MELD and MELD-Na systems in forecasting early hospital mortality risk among cirrhosis patients.

12. Author Contributions

K Bah, Ns Bah, AW Jallow and Dr M Touray conceived the study. K Bah was responsible for the methodology; K Bah, Ns Bah, & AW Jallow managed the software; K Bah, Ns Bah, AW Jallow & Dr M Touray were responsible for validation; K Bah, Ns Bah, AW Jallow & Dr M Touray conducted the formal analysis; K Bah, Ns Bah & AW Jallow conducted the investigation; K Bah was responsible for data curation; K Bah wrote the original draft; K Bah, Ns Bah, AW Jallow & Dr M Touray reviewed and edited the draft. All authors have read and agreed to the published version of the manuscript.

13. Financial Support

This study was conducted without the involvement of external funding sources.

14. Statement on Informed Consent

Given that our study exclusively employed de-identified data from the MIMIC III database, patient consent requirements were waived by the anonymous nature of the data.

15. Availability of Data

Although the data used in this study adheres to the data policy and regulations of MIMIC III, it may be made available by the corresponding author upon reasonable request.

16. Declaration of Conflicts of Interest

The authors affirm that they have no conflicts of interest to disclose related to this study's design, execution, or outcomes.

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