International Journal for Research in Bioscience
Published by: **Green Publication Services**
DOI: 10.53555/b.v1i2.2579
Volume 01 Issue 02 June 2026

CLINICAL AND BIOCHEMICAL PREDICTORS OF SURVIVAL OUTCOMES IN PATIENTS WITH LIVER CIRRHOSIS

Dr.Mohanakrishnan B

Junior Resident, Department of Naturopathy, MD in clinical Naturopathy, Swami Vivekanand Subharti University, Uttar Pradesh, India, Email Id: mkappu12@gmail.com, Orcid I'd: 0009-0005-2165-6636

Corresponding Author Dr.Mohanakrishnan B

ABSTRACT

SLiver cirrhosis is correlated with substantial morbidity and mortality, making the early identification of prognostic factors essential for effective clinical management. This study evaluated the clinical and biochemical predictors of survival outcomes in patients with liver cirrhosis. A showing unit analysis was conducted using patient-level clinical and laboratory data from 418 individuals. Overall survival was measured from study entry until death or censoring. Existence patterns were compared using Kaplan-Meier analysis and log-rank testing, and independent predictors of mortality were found using univariable and multivariable Cox proportional hazards regression models. During follow-up, 161 deaths were recorded. The estimated survival probabilities at one, three and five years were 92.8%, 80.1% and 70.3%, respectively. Survival was significantly poorer among patients with advanced histological stage and overt oedema. In the multivariable analysis, increasing age, overt oedema, elevated bilirubin, prolonged prothrombin time and advanced histological stage were independently associated with higher mortality. Higher serum albumin was independently associated with improved survival. The final model demonstrated strong discriminatory performance, with a Harrell's concordance index of 0.842. These findings indicate that routinely available clinical and biochemical indicators can effectively support survival prediction and early risk stratification in patients with liver cirrhosis.

Keywords: liver cirrhosis; survival analysis; bilirubin; albumin; mortality prediction

Article History:

Article Type: **Research**

Received Date:**05/05/2026** | Revised Date:**06/06/2026** | Accepted Date:**14/06/2026** | Published Date:**21/06/2026**

1. Introduction

Liver cirrhosis is the end stage of progressive hepatic fibrosis, associated with portal hypertension, impaired synthetic function, systemic inflammatory response, liver decompensation, liver transplantation and premature death. Routes of clinical evolution are variable between patients and early prediction is critical for accurate monitoring, escalation of care, and timely referral to transplant. The PREDICT study showed that the different clinical course of patients with acutely decompensated cirrhosis is associated with different pathophysiological profiles and survival probabilities (Trebicka et al., 2020). This heterogeneity makes it clear that the need for finding simple measurable factors that could be used to separate patients with a high mortality risk is significant.

Multiple clinical signs indicate more severe liver function impairment. Common signs of portal hypertension, fluid retention, or increased severity of disease are ascites, oedema, hepatomegaly and vascular skin signs. Refractory ascites has been associated with unfavourable outcomes among patients with cirrhosis awaiting liver transplantation (Giannelli et al., 2020). Sarcopenia is also an indicator of vulnerability to disease and associated with increased complications and decreased survival in cirrhotic individuals (Topan et al., 2021). Similarly, frailty scores have been shown to have a prognostic value for adverse clinical outcome in cirrhosis (Singh et al., 2022).

In advanced liver disease, body-composition abnormalities such as muscle wasting and fat redistribution also play a role in prognosis (Ebadi et al., 2020). Other studies also have linked myosteatosis with worse perioperative outcomes after liver transplantation (Czigany et al., 2020). Biochemical markers give more information on hepatocellular injury, cholestasis, and hepatic synthetic reserve and coagulation dysfunction. Reduced serum albumin concentrations are the most significant as they are often associated with a reduction in protein synthesis, systemic inflammation and poorer nutrition. In fact, low albumin has also been shown to be a poor prognosis marker in non-hepatic critical cardiovascular disorders, and therefore its general prognostic importance as a marker of systemic diseases. (Bicciré et al., 2021) In chronic liver failure (CLF) patients, high-density lipoprotein-related biomarkers have proven to have good survival predicting power (Trieb et al., 2020). Serum ferritin is also a predictor of long-term outcomes in metabolic dysfunction-associated steatotic liver disease (Metabolic Associated Steatotic Liver Disease) (Armandi et al., 2024).

Liver outcomes continue to be strongly associated with fibrosis severity. Taylor et al., (2020) conducted a systematic review and meta-analysis, demonstrating that the risk of mortality and

liver-related complications among patients with nonalcoholic fatty liver disease (NAFLD) is strongly linked to increasing fibrosis stage. The magnetic resonance or transient elastography of liver stiffness has also shown an ability to predict outcome in patients with primary biliary cholangitis (Osman et al., 2021). FIB-4 is a fibrosis-based tool that has proved to be a prognostic indicator in covid-19 patients and is still applicable in systemic infections (Ibáñez-Samaniego et al., 2020). Steatosis and fibrosis of the liver have also been linked to worse outcomes during SARS-CoV-2 infection (Lopez-Mendez et al., 2021). Underlying disease aetiology and comorbidities may further modify survival. Clinical outcomes of patients with compensated cirrhosis due to nonalcoholic steatohepatitis (NASH) have been linked with type 2 diabetes and metformin use (Vilar-Gomez et al., 2021). The PNPLA3 rs738409 variant has also been associated with liver-related outcomes in nonalcoholic fatty liver disease (NAFLD) (Grimaudo et al., 2020). The long-term prognosis varies from patient to patient with decompensated ALD depending on the severity of the disease and inflammatory profile (Degré et al., 2020). Acute systemic illness can significantly impact the prognosis of cirrhosis. Patients with SARS-CoV-2 infection have been shown to have worse outcomes with pre-existing liver disease (Sarin et al., 2020). Cirrhotic patients with COVID-19 have shown to be at the highest risk of complications and death (Shalimar et al., 2020).

A systematic review also showed liver injury in COVID-19 is linked to more severe clinical outcomes (Del Zompo et al., 2020). Multicentre cohorts of patients with chronic liver disease and COVID-19 have also reported predictors of adverse outcomes (Kim et al., 2021). Other hepatic populations also have been targeted for prognostic research, focusing on disease burden and organ dysfunction. Survival after ALF is strongly related to listing status and severity (Karvellas et al., 2023). In certain patients with acute liver failure (ALF), plasma exchange is effective in improving outcomes (Maiwall et al., 2022). Survival rate after surgical resection in hepatocellular carcinoma is significantly influenced by the tumour burden (Tsilimigras et al., 2020). Long-term survival is also affected by the recurrence characteristics after hepatic resection (Yao et al., 2022).

In hepatocellular carcinoma (Peng et al., 2020), the albumin–bilirubin grade has shown to be as useful as the Child–Pugh classification. Some of these predictors are not exclusively developed in studies of cirrhosis, but reflect the wide applicability of biochemical and physiological markers in predicting outcome. In dilated cardiomyopathy, right ventricular strain has been shown to be correlated with survival (Liu et al., 2020). The association of trimethylamine N-oxide with

cardiovascular outcomes after myocardial infarction (MI) in chronic heart failure (CHF) has been reported (Zhou et al., 2020).

These are corroborative of the general rule that clinically and biochemically identified disturbances increases patient mortality risk. The aim of the present study was to determine clinical and biochemical factors that predict survival in those patients with liver cirrhosis. They were included demographic data, clinical symptoms, histological stage, and routinely measured laboratory markers. The aim was to depict the patterns of survival, to compare survival outcomes between clinically relevant subgroups, to determine any unadjusted associations with death, and to identify unrelated predictors of death using multivariable survival analysis.

2. Methodology

2.1 Study Design

The aim of this study was to use a quantitative surveying cohort design to determine factors associated with survival in liver cirrhosis. Secondary patient-level data were analysed and the major outcome measures were survival duration and mortality status. The design allowed for the assessment of both the occurrence and timing of death over the follow-up period.

2.2 Study Population and Variables

The subjects of the study were 418 patients with liver cirrhosis. Survival data and follow-up time were available for the patients and were included in the analysis. Overall survival, defined as the number of days from study entry to demise, liver transplantation or end of follow-up was the primary outcome. Survival status was classified as death, censored alive or censored following liver transplantation. The primary analysis was coded with death as an event and patients who were still alive or underwent transplants as censored observation. The predictor variables were grouped into demographic, clinical and biochemical factors. Demographic data included age and sex. The age (in days) was divided by 365.25 to bring it to a year. Ascites, hepatomegaly, spider-angiomas, peripheral oedema and histological stage of liver disease were identified as clinical predictors. Treatment allocation was also considered to be a potential adjustment variable. Biochemical parameters were serum bilirubin, serum albumin, copper, alkaline phosphatase, serum glutamic oxaloacetic transaminase, cholesterol, triglycerides, platelet count and prothrombin time.

2.3 Data Preparation and Missing-Value Management

Duplicate records, coding inconsistencies, implausible values, missing observations and extreme values were screened out from the data. Patient identification numbers were not included in the statistical models because they were clinically and predictively irrelevant. All categorical variables were coded appropriately for analysis. The clinical variables were coded as binary, with the presence/absence of the condition, while oedema and disease stage were coded based on the categories they were recorded in. Biochemical variables were kept the same as continuous variables, when it was possible. Continuous variables were assessed by making histograms, box plots, skewness values and normality tests. Logarithmic transformations were considered to be applied to highly skewed biochemical values such as bilirubin, copper, alkaline phosphatase and transaminase levels. For each variable the extent and pattern of missing data were evaluated. Complete-case analysis was employed if there was little or no missing data. When there were missing data, they were added with great care and multiple imputation used when the missing at random assumption was warranted. A core model was used which included variables that had relatively full observations to avoid losing participants unnecessarily.

2.4 Descriptive and Survival Analysis

For continuous variables with roughly normal distributions, means and standard deviations were planned; for non-normally distributed variables, medians and interquartile ranges were computed. Frequencies and percentages were used to express categorical variables. Patients who died and those who were censored were compared based on their baseline characteristics. Depending on how the variables were distributed, independent-samples t-tests or Mann-Whitney U tests were employed for continuous variables. For categorical variables, Fisher's exact tests or chi-square tests were employed. For overall survival, the Kaplan-Meier method was applied. The various survival patterns by clinical and biochemical markers, including illness stage, ascites, oedema, bilirubin, and albumin, were displayed using Kaplan–Meier curves. Survival curve discrepancies were evaluated using the log rank test.

2.5 Cox Proportional Hazards Regression

Each of the clinical and biochemical predictors was tested for an association with the risk of death using univariable Cox proportional hazards failure analysis. Crude hazard ratios, 95% confidence interval and p values were computed. In the multivariate Cox regression model, variables with $p < 0.20$ in the univariate model were taken into consideration. Despite not being significant in the univariate analysis, age, sex, treatment status, and disease stage were regarded as relevant adjustment variables. To identify the independent risk factors for death, potential confounding

variables were incorporated into a multivariable Cox proportional hazards regression model. The final model's number of predictors was constrained by the number of documented fatalities in order to prevent overfitting. 95% confidence intervals (CIs) for hazard ratios (HRs) were displayed. An increased risk of death was indicated by a hazard ratio more than one, while a decreased risk of death was indicated by a hazard ratio less than one.

2.6 Model Assessment, Sensitivity Analysis and Ethics

Schoenfeld residuals and log-minus-log survival plots were used to test the proportional hazards assumption. Correlation coefficients, tolerance and VI statistics, were employed to test for multicollinearity. Residual and influence diagnostics were used to explore influential observations. Harrell's concordance index was used to assess the predictive ability of the final Cox model. Bootstrap resampling was used for internal validation to evaluate the stability of the model and possible model optimism. Complete case and imputed data analyses were compared using sensitivity analyses. Other variables with significant missing data were not included in an additional analysis. The question of whether the liver transplantation was treated as ordinary censoring and affected results was also explored by considering it as a competing event. All the tests were two tailed and a p value of less than 0.05 was deemed to be statistically significant. This analysis was based on secondary data that was anonymised. There was no personally identifiable information included, and the information was only used for academic research.

3.Result

3.1 Patient Characteristics and Survival Status

There were 418 patients with liver cirrhosis included in the analysis. A total of 161 patients died and 257 observations were censored (232 patients alive at the end of follow-up and 25 patients who were liver transplanted) during the follow-up. The median duration of follow up was 1730 days (IQR 1092.75 – 2613.50 days). Mortality was significantly higher in the patients than in the patients who were censored ($p<0.001$), with a mean age of 53.92 years for the patients compared to 48.75 years for the censored patients. The mortality group also showed significantly higher level of bilirubin, longer prothrombin time and more advanced histological stages of disease. On the other hand, the serum albumin and platelet counts were significantly decreased in the patients who had died. Patients who died were more likely to have clinical complications. 18.4% of patients who died and 0.5% of censored patients had ascites. Similarly, hepatomegaly, spider angiomas, overt oedema and stage IV disease were significantly more common among patients who died.

Table 1 shows that patients who died were older and had higher bilirubin, longer prothrombin time, more advanced histological stage, and more frequent clinical complications than censored patients. In contrast, albumin and platelet levels were lower in the mortality group.

Table 1. Baseline clinical and biochemical characteristics according to survival status

Characteristic	Overall (N = 418)	Deaths (n = 161)	Censored (n = 257)	p-value
Age, years	50.74 ± 10.45	53.92 ± 9.81	48.75 ± 10.36	<0.001
Follow-up duration, days	1,730.00 (1,092.75–2,613.50)	1,083.00 (597.00–2,071.00)	2,157.00 (1,419.00–2,863.00)	<0.001
Bilirubin, mg/dL	1.40 (0.80–3.40)	3.20 (1.40–7.10)	1.00 (0.70–1.80)	<0.001
Albumin, g/dL	3.50 ± 0.42	3.36 ± 0.47	3.58 ± 0.37	<0.001
Platelets, $10^3/mm^3$	251.00 (188.50–318.00)	224.00 (158.00–312.50)	258.50 (209.00–318.00)	0.003
Prothrombin time, seconds	10.73 ± 1.02	11.19 ± 1.05	10.44 ± 0.89	<0.001
Histological stage	3.00 (2.00–4.00)	4.00 (3.00–4.00)	3.00 (2.00–3.00)	<0.001
Male sex	44 (10.5%)	24 (14.9%)	20 (7.8%)	0.032
Ascites	24 (7.7%)*	23 (18.4%)*	1 (0.5%)*	<0.001
Hepatomegaly	160 (51.3%)*	88 (70.4%)*	72 (38.5%)*	<0.001
Spider angiomas	90 (28.8%)*	52 (41.6%)*	38 (20.3%)*	<0.001
Overt oedema	20 (4.8%)	19 (11.8%)	1 (0.4%)	<0.001
Stage IV disease	144 (35.0%)*	84 (53.5%)*	60 (23.5%)*	<0.001

* Percentages were based on the number of observations available due to missing values in some clinical variables. Continuous data are summarised as median (interquartile range) or mean ± standard deviation.

3.2 Overall Survival and Clinical Survival Patterns

Estimated probabilities of overall survival at 1, 3, 5 years were 92.8%, 80.1% and 70.3%, respectively, using Kaplan–Meier analysis. At follow-up, survival continued to fall over time, significantly so in patients with advanced disease and clinically significant fluid retention. Survival was significantly related to histological stage. Five-year survival was 88.6% among patients with stage I–II disease, 77.9% among patients with stage III disease and 46.9% among patients with stage IV disease. The log-rank test ($\chi^2 = 68.92$, $p < 0.001$) found the differences between the groups of stages to be statistically significant. Substantial differences in survival were also seen relating to oedema. The estimated five-year survival was 76.7% in patients without oedema, 47.0% in those with medically controlled oedema and 7.5% in those with overt oedema. The survival curves were found to be significantly different between the oedema categories ($\chi^2 = 130.59$, $p < 0.001$). Table

2 shows a progressive decline in survival with increasing histological stage and severity of oedema. Patients with stage IV disease and overt oedema demonstrated the lowest one-, three-, and five-year survival probabilities. Figure 1 shows a gradual decline in the overall survival probability of patients with liver cirrhosis throughout the follow-up period. The curve indicates that mortality accumulated progressively over time. Figure 2 shows clear separation of survival curves according to histological stage. Patients with stage IV disease experienced substantially poorer survival than those with stage III or stage I–II disease.

Table 2. Kaplan–Meier survival estimates according to disease stage and oedema status

Group	N	Deaths	One-year survival	Three-year survival	Five-year survival
Overall cohort	418	161	92.8%	80.1%	70.3%
Stage I–II	113	25	99.1%	92.8%	88.6%
Stage III	155	48	97.4%	90.2%	77.9%
Stage IV	144	84	83.3%	59.8%	46.9%
No oedema	354	116	96.6%	85.6%	76.7%
Controlled oedema	44	26	84.1%	63.6%	47.0%
Overt oedema	20	19	45.0%	20.0%	7.5%

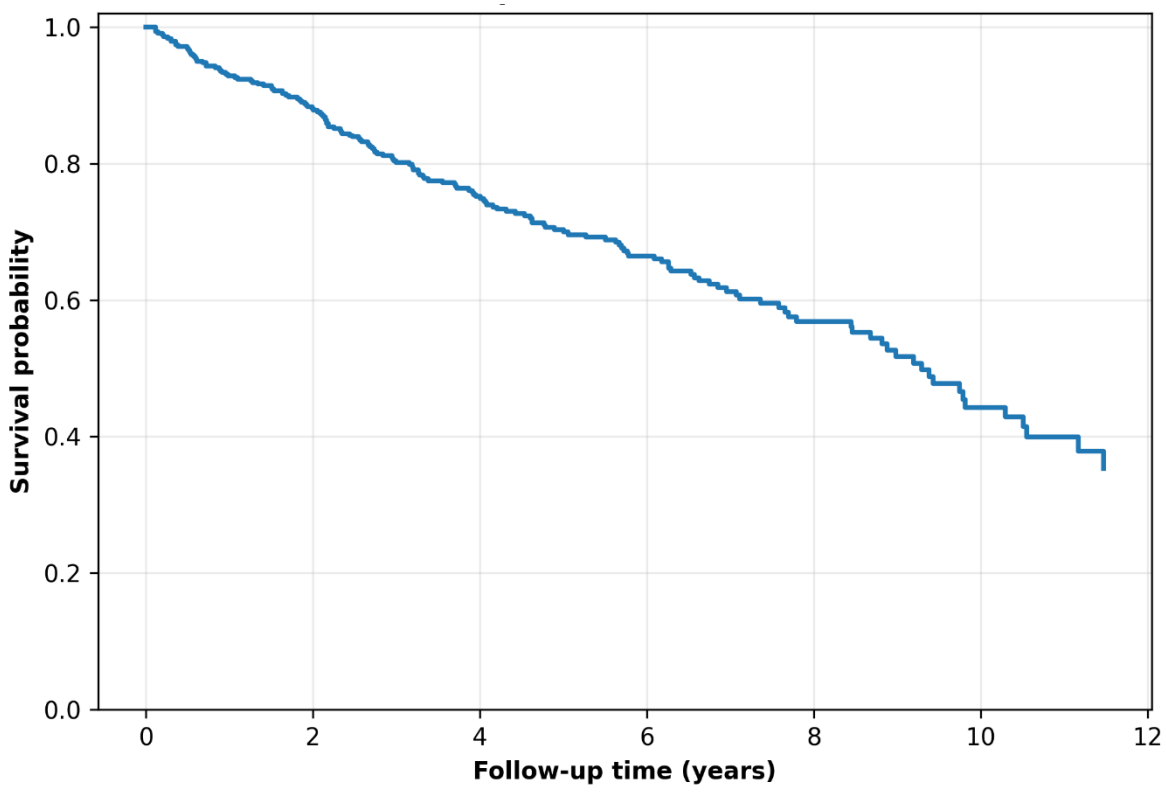

Figure 1. Overall Kaplan–Meier survival curve for patients with liver cirrhosis.

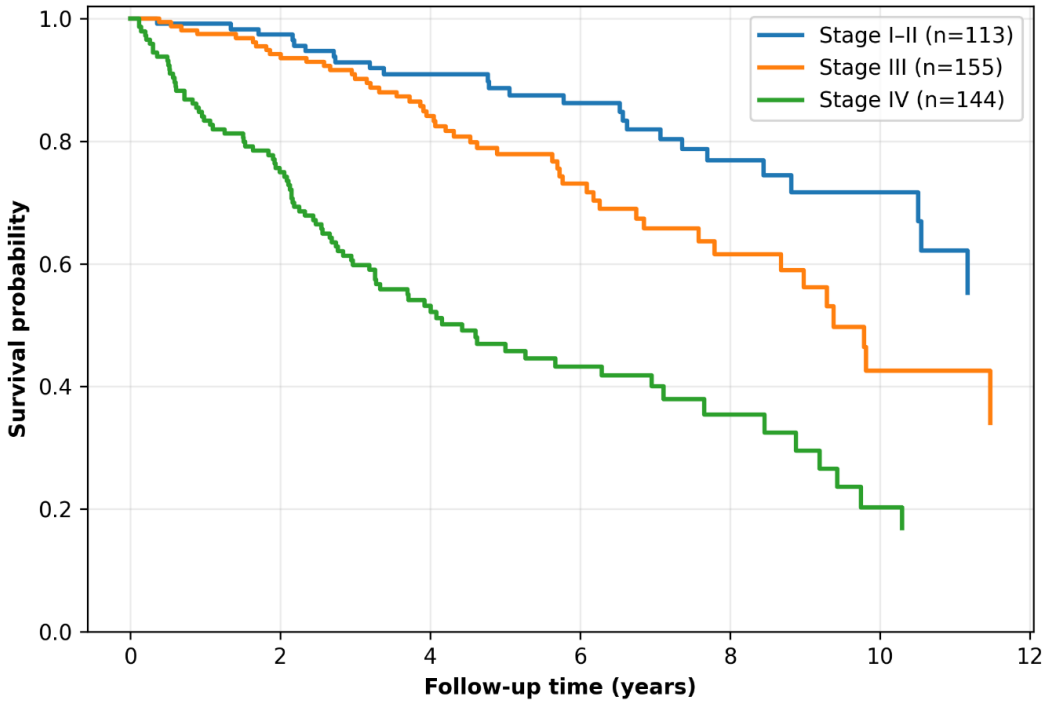

Figure 2. Kaplan–Meier survival curves according to histological stage of liver cirrhosis.

3.3 Univariable Predictors of Mortality

Several demographic, clinical and biochemical factors were identified by univariable Cox proportional hazards analysis to be associated with impermanence. Every 10-year increase in age was associated with a 48.0% increase in the mortality hazard (HR = 1.48, 95% CI: 1.27–1.73, $p < 0.001$). A strong association with impermanence was seen for Oedema. Patients with controlled oedema had a more than twofold increase in the hazard of death (HR = 2.19, 95% CI: 1.44–3.33); patients with overt oedema had approximately ninefold increase in the hazard of death (HR = 9.05, 95% CI: 5.54–14.80) compared with patients without oedema. The odds of death were significantly higher with higher bilirubin (HR 2.69 per log-unit increase in bilirubin, 95% CI: 2.31-3.13). Each 1 g/dl higher albumin level was protective, and was accompanying with a decreased hazard of death of about 79% (HR = 0.21, 95% CI: 0.15–0.31). Mortality was negatively correlated with higher platelet count, and positively correlated with longer prothrombin time and more advanced histological stage. The hazard ratio was higher among males, although this was not statistically significant in the univariable survival model. Table 3 shows that age, oedema, bilirubin, albumin, platelet count, prothrombin time, and histological stage were significantly associated with mortality in the univariable Cox analysis. Overt oedema and elevated bilirubin produced the strongest increases in mortality hazard.

Table 3. Univariable Cox proportional hazards analysis of mortality predictors

Predictor	N	Hazard ratio	95% CI	p-value
Age, per 10-year increase	418	1.48	1.27–1.73	<0.001
Male sex	418	1.46	0.95–2.26	0.086
Controlled oedema	418	2.19	1.44–3.33	<0.001
Overt oedema	418	9.05	5.54–14.80	<0.001
Log-transformed bilirubin	418	2.69	2.31–3.13	<0.001
Albumin, per 1 g/dL increase	418	0.21	0.15–0.31	<0.001
Platelets, per 50-unit increase	407	0.88	0.80–0.96	0.003
Prothrombin time, per one-second increase	416	1.30	1.19–1.42	<0.001
Histological stage, per stage increase	412	2.22	1.79–2.74	<0.001

3.4 Independent Clinical and Biochemical Predictors

There were 399 patients with complete data for the chosen variables, including 150 deaths, of whom 30 were the cause of the selected events. Following simultaneous adjustments, age, presence of overt oedema, bilirubin, albumin, prothrombin time (PT) and histological stage were still independently associated with the mortality. The chance of dying increased by 32.3% for every ten years of age (adjusted HR = 1.32, 95% CI: 1.12–1.56, $p < 0.001$). There was a 2.44-fold greater mortality hazard for patients with overt oedema compared to those without oedema (adjusted HR = 2.44, 95% CI: 1.34–4.45, $p = 0.004$). The most powerful independent biochemical risk factor was log-transformed bilirubin. The mortality hazard had more than double per 1 unit increase (adjusted HR = 2.25, 95% CI: 1.89–2.68, $p < 0.001$). In contrast, higher albumin remained protective (adjusted HR = 0.48, 95% CI: 0.31–0.75, $p = 0.001$). For the histological stage, each unit increase in the stage was associated with a 34.4% increase in the hazard of mortality (adjusted HR = 1.34, 95% CI: 1.06–1.70; $p = 0.014$) and longer prothrombin time was associated with increased mortality (adjusted HR = 1.31 per second, 95% CI: 1.10–1.54; $p = 0.002$). After adjusting for the other clinical and biochemical factors, male sex and controlled oedema and platelet count were not independent factors. Table 4 shows that age, overt oedema, bilirubin, prothrombin time, and histological stage remained independent mortality predictors after adjustment. Higher albumin was independently associated with a reduced risk of death. Figure 3 shows the adjusted hazard ratios and confidence intervals for the predictors included in the multivariable Cox model. Overt oedema and elevated bilirubin were the strongest risk factors, while albumin demonstrated a protective association.

Table 4. Multivariable Cox proportional hazards model for independent mortality predictors

Predictor	Adjusted HR	95% CI	p-value	Interpretation
Age, per 10-year increase	1.32	1.12–1.56	0.001	Increased mortality risk
Male sex	1.32	0.82–2.13	0.252	Not independently significant
Controlled oedema	1.27	0.79–2.02	0.324	Not independently significant
Overt oedema	2.44	1.34–4.45	0.004	Increased mortality risk
Log-transformed bilirubin	2.25	1.89–2.68	<0.001	Increased mortality risk
Albumin, per 1 g/dL increase	0.48	0.31–0.75	0.001	Protective association
Platelets, per 50-unit increase	0.98	0.90–1.07	0.634	Not independently significant
Prothrombin time, per one-second increase	1.31	1.10–1.54	0.002	Increased mortality risk
Histological stage, per stage increase	1.34	1.06–1.70	0.014	Increased mortality risk

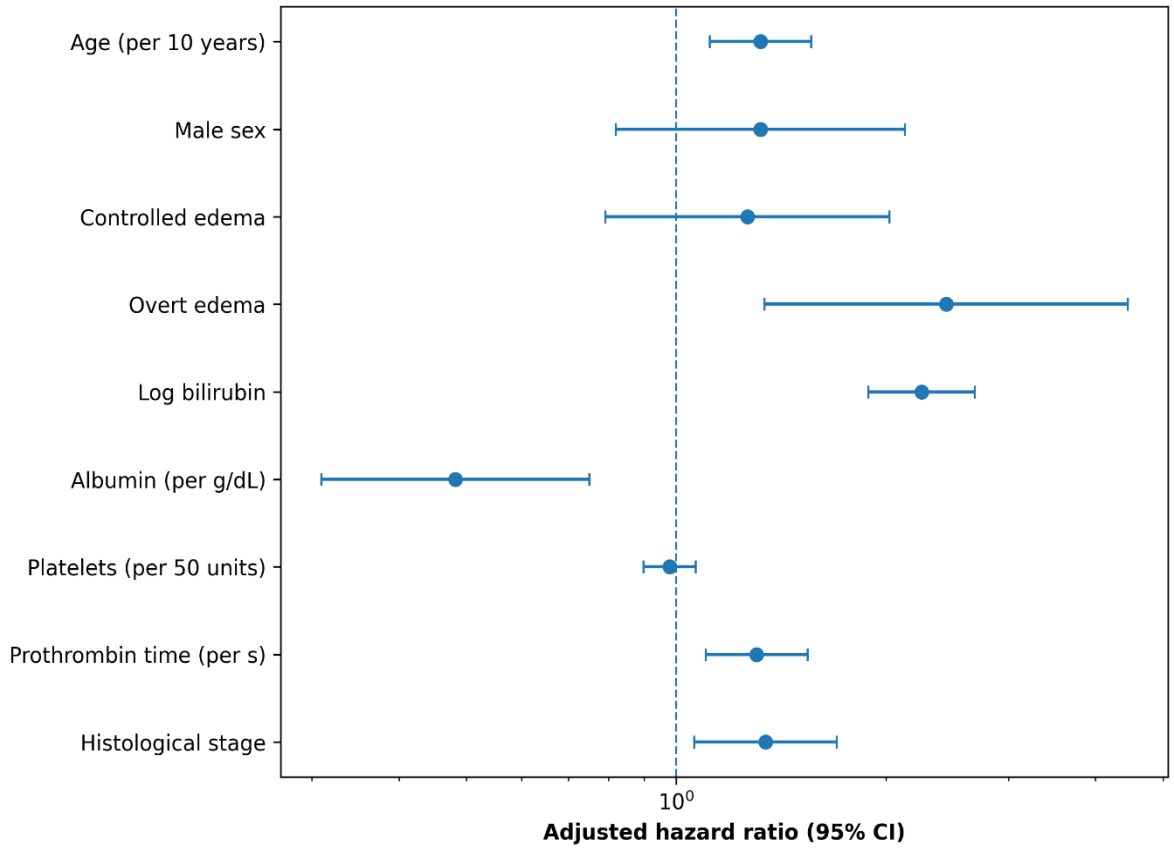

Figure 3. Forest plot of adjusted hazard ratios for clinical and biochemical predictors of mortality.

3.5 Model Discrimination and Risk Stratification

Finally, there was very good discrimination in the final multivariable Cox model, with a Harrell's concordance index of 0.842. This shows that the model was able to accurately order the survival probabilities of about 84.2% of comparable patients. Based on the tertiles of the estimated risk of death, patients were categorised into low-risk, intermediate-risk, and high-risk groups. The Kaplan-Meier survival curves differed significantly from one another. Patients in the low-risk group experienced a marked improvement in survival over follow-up, while those in the high-risk group experienced the fastest decline in survival. The difference between each risk group was statistically significant (log-rank $\chi^2 = 209.70$, $p < 0.001$). The results show that age, oedema, bilirubin, albumin, prothrombin time and histological stage are able to reliably separate patients with a relatively good prognosis from those with a markedly higher risk of mortality. Figure 4 shows marked differences in survival among the low-, intermediate-, and high-risk groups. The high-risk group experienced the fastest decline in survival, whereas the low-risk group maintained the most favourable outcomes.

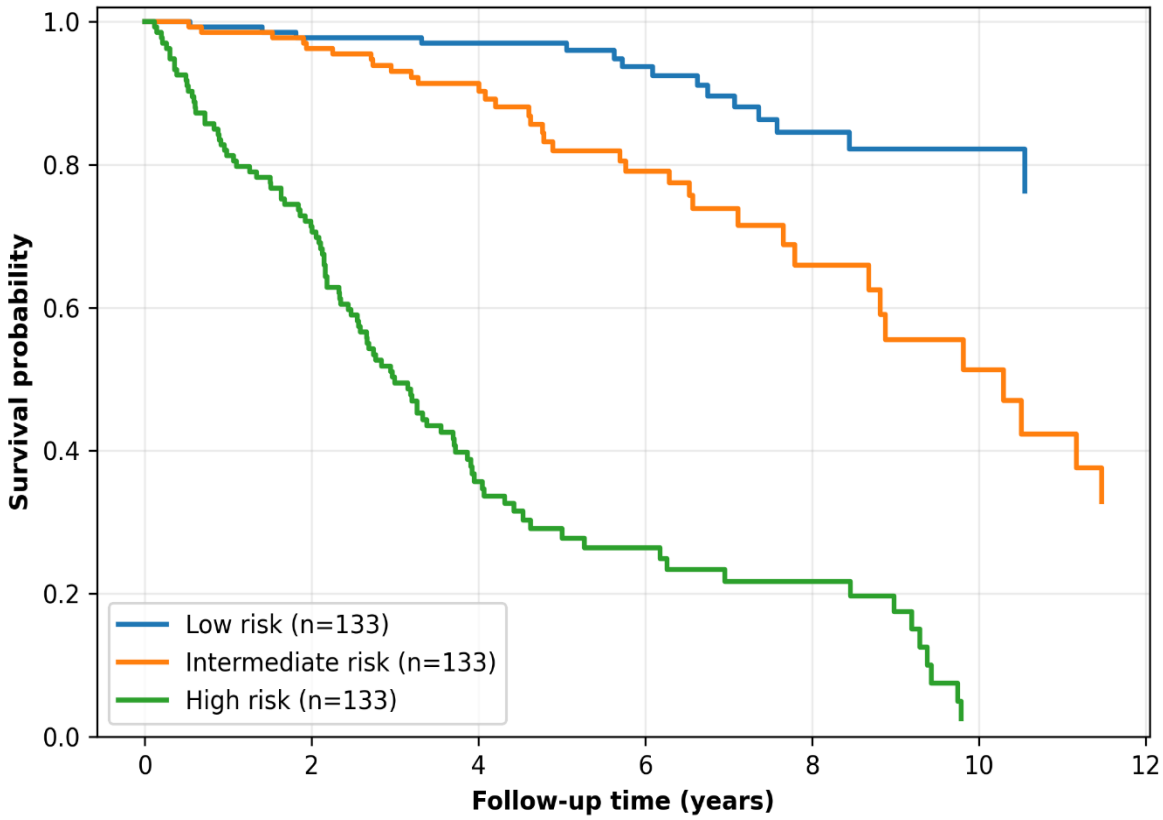

Figure 4. Kaplan–Meier survival curves for low-, intermediate- and high-risk groups derived from the multivariable Cox model.

4. Discussion

In the present study age, overt oedema, serum bilirubin, serum albumin and histological stage were found to be free predictors of mortality in patients with liver cirrhosis. The final model achieved an excellent discriminatory capacity suggesting that a combination of routinely available clinical and biological parameters can yield clinically relevant stratification of survival. The marked difference in survival curves of the Kaplan–Meier curves for the various disease-stage and risk groups confirms the predictive value of hepatic functional impairment and advanced clinical decompensation. Other predictors were also controlled for, and age was still a significant predictor of mortality.

This discovery could be due to decreased capacity to compensate for liver disease, increased comorbidity burden and decreased ability to recover from liver decompensation. The observed correlation is in line with the evidence from previous studies that survival in advanced liver disease is influenced by both liver specific abnormalities and systemic vulnerability and general health status. The strongest clinical predictor in the multivariable model was oedema. Mortality was significantly higher in patients with overt oedema, suggesting that clinical signs of fluid retention are related to advanced circulatory dysfunction, portal hypertension and impaired sodium handling. This is supported by the fact that refractory ascites is a negative prognostic factor in the transplant-listed cirrhosis population (Giannelli et al., 2020). The present analysis also shows a strong association between ascites and death, which further indicates that the presence of ascites marks decompensated disease. Bilirubin was the most powerful biochemical risk factor. After adjustment, the hazard of death was greater than twofold higher with increasing bilirubin concentrations. Bilirubin is a marker of hepatic excretory failure and cholestasis, and is a key factor in many commonly used indices of prognosis. Evidence also suggests that the albumin–bilirubin-based grading is a good predictor of outcomes in patients with hepatocellular carcinoma (Peng et al., 2020).

The present results indicate that bilirubin is still a very useful marker in addition to clinical stage and other biochemical markers of coagulation. In contrast, serum albumin showed a protective association, with increased levels of serum albumin associated with decreased mortality. Albumin reflects hepatic synthetic reserve, nutritional state and systemic inflammatory activity. As previously shown, lipoprotein-related biomarkers can predict survival in CLF (Trieb et al., 2020) and the same applies to albumin here. It also validates evidence that low albumin is a marker for poor outcomes in other severe systemic diseases (Bicciré et al., 2021). So, a decreased albumin

level could reflect a decline in the liver function and in general physiology. Increased prothrombin time was an independent predictor of mortality and was an important part of the investigation of advanced liver disease because of decreased coagulation factor production. This is a biologically plausible finding because as the hepatic cells begin to fail, they also are unable to synthesize the coagulation proteins, which is an indicator of hepatic synthetic capacity.

It is noteworthy that bilirubin, albumin and prothrombin time are all independently associated with survival, as it suggests that various aspects of liver function are important. Histological stage also was an independent predictor, and five-year survival was significantly lower for those with advanced-stage disease. These findings are consistent with existing studies which have demonstrated a graded relationship between fibrosis severity and liver events (Taylor et al., 2020). This result also aligns with previous studies showing that liver stiffness is an independent risk factor for prognosis in primary biliary cholangitis (Osman et al., 2021). These results further emphasize the need for the evaluation of a disease stage in chronic clinical decisions. In univariable analysis platelet count was associated with mortality, but not after multivariable adjustment. Platelets can also be affected by portal hypertension, splenic sequestration, severity of disease but may overlap with the prognostic information provided by the histological stage and other markers of decompensation. Likewise, having controlled oedema was not an independent predictor; mild or medically controlled oedema may be a less important prognostic factor than overt oedema.

The high discriminatory ability of the final model suggests that it could be applicable to clinical risk stratification. In terms of survival, there were substantially fewer patients in the high-risk category than in the low-risk and intermediate-risk categories. These layers of stratification may facilitate more surveillance, earlier specialist review, nutritional management and decompensation, and assessment of transplantation. However, the predictive power needs to be tested in an external setting before it can be used in the clinical practice. There are a few caveats to note.

There were considerable missing data in some clinical and biochemical variables, and they were not suitable for use in the primary model. Creatinine, sodium, encephalopathy, and directly recorded international normalised ratio (INR) were not available because they were not important contemporary predictors. Thus, existing scores like MELD-Na and complete Child–Pugh classification were not re-constructed. Additionally the cohort is drawn from a certain population of cirrhosis, which could restrict generalisation to all cirrhosis aetiologies. Nevertheless, the results indicate that there is significant prognostic information in routinely acquired clinical and

biochemical parameters. Age, overt oedema, bilirubin, albumin, prothrombin time and disease stage may be useful practical parameters for stratifying patients for those at high risk of mortality and those who warrant more aggressive clinical management.

5. Conclusion

The importance of the effects of clinical severity, biochemical dysfunction and demographic factors on survival in liver cirrhosis patients was illustrated in this study. Older age, overt oedema, higher serum bilirubin and higher histological stage were each independently predictive of mortality. Conversely, increased serum albumin concentrations showed to be associated with a better outcome, suggesting that an intact hepatic synthetic function is protective. The survival analysis also revealed meaningful differences in long-term results between patients with advanced disease stage and clinically evident oedema. The discriminatory performance of the multivariable model was good, and it makes it clear that simple routinely available clinical and laboratory measurements can well identify patients with low, intermediate and high mortality risk. These data suggest that bilirubin, albumin, prothrombin time, oedema status, age and disease stage are practical markers for liver cirrhosis prognosis. This joint assessment may help clinicians recognise patients at high risk who would benefit from more intensive supervising and assessment for specialist or transplantation services. The results, however, must be interpreted with the awareness of missing observations and lack of some well-known prognostic variables. This proposed model will need to be externally validated in larger and more diverse populations of cirrhosis before it can be used in clinical practice for routine decision making.

References

1. Armandi, A., Sanavia, T., Younes, R., Caviglia, G. P., Rosso, C., Govaere, O., ... & Bugianesi, E. (2024). Serum ferritin levels can predict long-term outcomes in patients with metabolic dysfunction-associated steatotic liver disease. Gut, 73(5).
2. Bicciré, F. G., Pastori, D., Tanzilli, A., Pignatelli, P., Viceconte, N., Barillà, F., ... & Tanzilli, G. (2021). Low serum albumin levels and in-hospital outcomes in patients with ST segment elevation myocardial infarction. Nutrition, Metabolism and Cardiovascular Diseases, 31(10), 2904-2911.
3. Czigany, Z., Kramp, W., Bednarsch, J., van der Kroft, G., Boecker, J., Strnad, P., ... & Lurje, G. (2020). Myosteatosis to predict inferior perioperative outcome in patients undergoing orthotopic liver transplantation. American Journal of Transplantation, 20(2), 493-503.

4. Degré, D., Stauber, R. E., Englebert, G., Sarocchi, F., Verset, L., Rainer, F., ... & Moreno, C. (2020). Long-term outcomes in patients with decompensated alcohol-related liver disease, steatohepatitis and Maddrey's discriminant function< 32. Journal of hepatology, 72(4), 636-642.
5. Del Zompo, F., De Siena, M., Ianiro, G., Gasbarrini, A., Pompili, M., & Ponziani, F. R. (2020). Prevalence of liver injury and correlation with clinical outcomes in patients with COVID-19: systematic review with meta-analysis. European Review for Medical & Pharmacological Sciences, 24(24).
6. Ebadi, M., Bhanji, R. A., Tandon, P., Mazurak, V., Baracos, V. E., & Montano-Loza, A. J. (2020). prognostic significance of body composition abnormalities in patients with cirrhosis. Alimentary Pharmacology & Therapeutics, 52(4), 600-618.
7. Giannelli, V., Roux, O., Laouénan, C., Manchon, P., Ausloos, F., Bachelet, D., ... & Francoz, C. (2020). Impact of cardiac function, refractory ascites and beta blockers on the outcome of patients with cirrhosis listed for liver transplantation. Journal of Hepatology, 72(3), 463-471.
8. Grimaudo, S., Pipitone, R. M., Pennisi, G., Celsa, C., Cammà, C., Di Marco, V., ... & Petta, S. (2020). Association between PNPLA3 rs738409 C> G variant and liver-related outcomes in patients with nonalcoholic fatty liver disease. Clinical Gastroenterology and Hepatology, 18(4), 935-944.
9. Ibáñez-Samaniego, L., Bighelli, F., Usón, C., Caravaca, C., Carrillo, C. F., Romero, M., ... & Bañares, R. (2020). Elevation of liver fibrosis index FIB-4 is associated with poor clinical outcomes in patients with COVID-19. Journal of Infectious Diseases, 222(5), 726-733.
10. Karvellas, C. J., Leventhal, T. M., Rakela, J. L., Zhang, J., Durkalski, V., Reddy, K. R., ... & Parekh, J. R. (2023). Outcomes of patients with acute liver failure listed for liver transplantation: a multicenter prospective cohort analysis. Liver Transplantation, 29(3), 318-330.
11. Kim, D., Adeniji, N., Latt, N., Kumar, S., Bloom, P. P., Aby, E. S., ... & Dhanasekaran, R. (2021). Predictors of outcomes of COVID-19 in patients with chronic liver disease: US multi-center study. Clinical Gastroenterology and Hepatology, 19(7), 1469-1479.
12. Liu, T., Gao, Y., Wang, H., Zhou, Z., Wang, R., Chang, S. S., ... & Xu, L. (2020). Association between right ventricular strain and outcomes in patients with dilated cardiomyopathy. Heart.
13. Lopez-Mendez, I., Aquino-Matus, J., Gall, S. M. B., Prieto-Nava, J. D., Juarez-Hernandez, E., Uribe, M., & Castro-Narro, G. (2021). Association of liver steatosis and fibrosis with clinical outcomes in patients with SARS-CoV-2 infection (COVID-19). Annals of Hepatology, 20, 100271.
14. Maiwall, R., Bajpai, M., Singh, A., Agarwal, T., Kumar, G., Bharadwaj, A., ... & Sarin, S. K. (2022). Standard-volume plasma exchange improves outcomes in patients with acute liver failure: a randomized controlled trial. Clinical Gastroenterology and Hepatology, 20(4), e831-e854.

15. Osman, K. T., Maselli, D. B., Idilman, I. S., Rowan, D. J., Viehman, J. K., Harmsen, W. S., ... & Eaton, J. E. (2021). Liver stiffness measured by either magnetic resonance or transient elastography is associated with liver fibrosis and is an independent predictor of outcomes among patients with primary biliary cholangitis. Journal of clinical gastroenterology, 55(5), 449-457.
16. Peng, Y., Wei, Q., He, Y., Xie, Q., Liang, Y., Zhang, L., ... & Chai, J. (2020). ALBI versus child-pugh in predicting outcome of patients with HCC: a systematic review. Expert review of gastroenterology & hepatology, 14(5), 383-400.
17. Sarin, S. K., Choudhury, A., Lau, G. K., Zheng, M. H., Ji, D., Abd-Elsalam, S., ... & APASL COVID Task Force, APASL COVID Liver Injury Spectrum Study (APCOLIS Study-NCT 04345640). (2020). Pre-existing liver disease is associated with poor outcome in patients with SARS CoV2 infection; The APCOLIS Study (APASL COVID-19 Liver Injury Spectrum Study). Hepatology international, 14(5), 690-700.
18. Shalimar, Elhence, A., Vaishnav, M., Kumar, R., Pathak, P., Soni, K. D., ... & Garg, P. (2020). Poor outcomes in patients with cirrhosis and Corona Virus Disease-19. Indian Journal of Gastroenterology, 39(3), 285-291.
19. Singh, S., Taneja, S., Tandon, P., Bansal, A., Gorsi, U., Roy, A., ... & Singh, V. (2022). A comparison of different frailty scores and impact of frailty on outcome in patients with cirrhosis. Journal of clinical and experimental hepatology, 12(2), 398-408.
20. Taylor, R. S., Taylor, R. J., Bayliss, S., Hagström, H., Nasr, P., Schattenberg, J. M., ... & Newsome, P. N. (2020). Association between fibrosis stage and outcomes of patients with nonalcoholic fatty liver disease: a systematic review and meta-analysis. Gastroenterology, 158(6), 1611-1625.
21. Topan, M. M., Sporea, I., Dănilă, M., Popescu, A., Ghiuchici, A. M., Lupuşoru, R., & Şirli, R. (2021). Impact of sarcopenia on survival and clinical outcomes in patients with liver cirrhosis. Frontiers in nutrition, 8, 766451.
22. Trebicka, J., Fernandez, J., Papp, M., Caraceni, P., Laleman, W., Gambino, C., ... & Engelmann, C. (2020). The PREDICT study uncovers three clinical courses of acutely decompensated cirrhosis that have distinct pathophysiology. Journal of hepatology, 73(4), 842-854.
23. Trieb, M., Rainer, F., Stadlbauer, V., Douschan, P., Horvath, A., Binder, L., ... & Stauber, R. E. (2020). HDL-related biomarkers are robust predictors of survival in patients with chronic liver failure. Journal of hepatology, 73(1), 113-120.
24. Tsilimigras, D. I., Mehta, R., Paredes, A. Z., Moris, D., Sahara, K., Bagante, F., ... & Pawlik, T. M. (2020). Overall tumor burden dictates outcomes for patients undergoing resection of multinodular hepatocellular carcinoma beyond the Milan criteria. Annals of surgery, 272(4), 574-581.
25. Vilar-Gomez, E., Calzadilla-Bertot, L., Wong, V. W. S., Castellanos, M., Aller-de la Fuente, R., Eslam, M., ... & Adams, L. A. (2021). Type 2 diabetes and metformin use associate with outcomes

of patients with nonalcoholic steatohepatitis–related, Child–Pugh A cirrhosis. Clinical Gastroenterology and Hepatology, 19(1), 136-145.

26. Yao, L. Q., Chen, Z. L., Feng, Z. H., Diao, Y. K., Li, C., Sun, H. Y., ... & Yang, T. (2022). Clinical features of recurrence after hepatic resection for early-stage hepatocellular carcinoma and long-term survival outcomes of patients with recurrence: a multi-institutional analysis. Annals of surgical oncology, 29(7), 4291-4303.
27. Zhou, X., Jin, M., Liu, L., Yu, Z., Lu, X., & Zhang, H. (2020). Trimethylamine N-oxide and cardiovascular outcomes in patients with chronic heart failure after myocardial infarction. ESC heart failure, 7(1), 189-194.