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Comparative Predictive Accuracy of Child-Pugh and MELD Scores in Prognosis of Liver Cirrhosis and Evaluation of Serum Ferritin Levels

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Liver cirrhosis is a leading cause of morbidity and mortality worldwide. Accurate prognostication is crucial for timely interventions and optimal management. Child-Pugh and MELD scores are widely used prognostic tools, but their relative effectiveness remains debated.
Aim: To compare the predictive accuracy of Child-Pugh and MELD scores in determining mortality in liver cirrhosis patients and evaluate the prognostic value of serum ferritin levels.

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Methods: This prospective observational study enrolled 50 patients with liver cirrhosis admitted to a tertiary care hospital between November 2022 and March 2023. Patients were assessed using Child-Pugh and MELD scores at admission and after three months. Serum ferritin levels were measured, and clinical outcomes were recorded. Statistical analysis employed SPSS version 22.0.
Results: The majority of patients (46%) were aged 41-60 years, with a male predominance (90%). Jaundice (94%), ascites (38%), and hepatic encephalopathy (16%) were common presentations. The overall mortality rate was 24%. Child-Pugh scores correlated significantly with mortality ($p < 0.01$). Survival rates for Child-Pugh classes A, B, and C were 100%, 80%, and 45%, respectively. Patients with serum ferritin levels >500 ng/mL had significantly lower survival rates (61%) compared to those with levels <500 ng/mL (88%). The Child-Pugh score demonstrated greater short-term predictive accuracy (AUC = 0.85) compared to the MELD score (AUC = 0.78).
Conclusion: This study highlights the importance of Child-Pugh and MELD scores in predicting mortality in liver cirrhosis. Elevated serum ferritin levels (>500 ng/mL) emerge as an independent prognostic marker for poor outcomes. Integration of clinical scoring systems and biomarkers can enhance predictive accuracy and guide therapeutic decision-making. These findings have significant implications for risk stratification, personalized treatment, and liver transplant prioritization. Future research should focus on validating these findings and exploring underlying mechanisms to improve liver cirrhosis management.

Keywords: Liver cirrhosis; child-pugh score; MELD score; serum ferritin, prognosis.

1. INTRODUCTION

Liver cirrhosis, a pathological endpoint of chronic liver diseases, is characterized by the histomorpho logical hallmark of regenerative nodules surrounded by fibrous tissue, culminating in significant hepatic dysfunction and hemodynamic disturbances [1]. This irreversible scarring process results from prolonged liver injury, inflammation, and fibrogenesis, ultimately compromising liver function and patient survival. Cirrhosis accounts for over 1 million deaths annually worldwide, emphasizing the need for early diagnosis and effective management strategies [2]. The global prevalence of cirrhosis is estimated to be 0.15-1.5%, with varying etiologies, including hepatitis B and C, alcohol consumption, non-alcoholic fatty liver disease (NAFLD), and non-alcoholic steatohepatitis (NASH) [3].

Early diagnosis of cirrhosis is often hindered by the asymptomatic nature of initial stages, delaying intervention until complications arise, such as variceal bleeding, ascites, hepatic encephalopathy, and spontaneous bacterial peritonitis. The Child-Pugh (CP) and Model for End-Stage Liver Disease (MELD) scores are widely employed prognostic tools, but their relative effectiveness remains debated [4]. The CP score integrates clinical parameters, including albumin, bilirubin, prothrombin time, ascites, and encephalopathy, while the MELD score relies on objective laboratory values, such as bilirubin, creatinine, and international normalized ratio (INR).

This study aims to compare the predictive accuracy of CP and MELD scores in determining liver cirrhosis patient prognosis and evaluate the prognostic value of serum ferritin levels in these patients. Elevated serum ferritin levels have been linked to liver inflammation, fibrosis, and poor prognosis in cirrhotic patients [5].

2. METHODS

2.1 Study Design

This prospective observational study employed a cohort design to investigate the predictive accuracy of Child-Pugh and Model for End-Stage Liver Disease (MELD) scores in patients with liver cirrhosis, while evaluating the prognostic utility of serum ferritin levels.

2.2 Study Setting and Duration

The study was conducted at the Medicine department of Chhatrapati Shivaji Subharti Hospital, Meerut, UP, India, over a period of six months (November 2022 to March 2023).

2.3 Inclusion and Exclusion Criteria

2.3.1 Inclusion criteria

1. Patients aged ≥ 18 years
2. Clinically and radiologically confirmed liver cirrhosis
3. Ability to provide informed consent

2.3.2 Exclusion criteria

1. Pre-existing renal disease
2. Bleeding disorders
3. Ascites due to causes other than cirrhosis

2.4 Data Collection

A structured questionnaire was used to collect:

1. Demographic data (age, sex, ethnicity)
2. Clinical parameters (medical history, physical examination)
3. Laboratory parameters:

- Liver function tests (LFTs): alanine transaminase (ALT), aspartate transaminase (AST), total bilirubin, albumin
- Coagulation profiles: prothrombin time (PT), international normalized ratio (INR)
- Renal function tests (RFTs): serum creatinine, urea
- Serum iron studies: ferritin, iron, total iron-binding capacity (TIBC)

4. Radiological findings: ultrasound, computed tomography (CT) scans

2.5 Child-Pugh and MELD Scoring

Child-Pugh and MELD scores were calculated for each patient at admission and after three months using standard formulas.

2.6 Serum Ferritin Measurement

Serum ferritin levels were measured using enzyme-linked immunosorbent assay (ELISA) kits.

2.7 Data Analysis

Statistical analysis was performed using IBM SPSS Statistics version 22.0.

1. Descriptive statistics: mean, standard deviation (SD), frequency
2. Inferential statistics:
- Chi-square test for categorical variables
- Independent t-test for continuous variables
- Pearson's correlation coefficient for correlation analysis
- Multivariate regression analysis for adjusting confounding variables
3. Significance level: $p < 0.05$

2.8 Sample Size Calculation

The sample size was calculated using the formula:

$$n = (Z^2 * p * (1-p)) / E^2$$

where n = sample size, Z = Z-score (1.96), p = expected proportion (0.5), E = margin of error (0.05)

List 1: Sample size calculation

2.9 Power Analysis

A post-hoc power analysis was conducted to determine the study's power to detect significant differences.

By employing this rigorous methodology, this study aimed to provide valuable insights into the predictive accuracy of Child-Pugh and MELD scores and the prognostic utility of serum ferritin levels in patients with liver cirrhosis.

3. RESULTS

3.1 Demographic and Clinical Characteristics

The study cohort consisted of 50 patients with liver cirrhosis, exhibiting a notable demographic distribution:

The study population showed a predominant age distribution between 41-60 years, accounting for 46% of enrolled patients, followed by those under 40 years (36%) and above 60 years (18%) [Table 1].

Table 1. Age wise categorization of patients in percentages

Gender	Number of cases	Percentage
Male	45	90
Female	5	10
Total	**50**	**100**

Table 2. Showing percentage wise categorization of patients' gender

Gender	Number of cases	Percentage
Male	45	90
Female	5	10
Total	**50**	**100**

The gender distribution revealed a pronounced male majority, accounting for 90% of enrolled patients, whereas females comprised only 10% [Table 2].

3.2 Clinical Presentation

Patients presented with:

- Jaundice (94%)
- Ascites (38%)
- Hepatic encephalopathy (16%)
- Hematemesis (16%)
- Melena (16%)

3.3 Mortality and Survival Outcomes

The overall mortality rate was 24%. Notably:

- Child-Pugh scores correlated significantly with mortality ($p < 0.01$)
- Survival rates for Child-Pugh classes:

- A: 100%
- B: 80%
- C: 45%

- Serum ferritin levels >500 ng/mL associated with lower survival rates (61%) vs. ≤500 ng/mL (88%)

3.4 Prognostic Accuracy and Predictive Value

The study revealed:

- Child-Pugh score demonstrated superior short-term predictive accuracy for liver cirrhosis prognosis (AUC = 0.85)
- MELD score effectively identified patients at high risk of poor outcomes (AUC = 0.78)
- Elevated serum ferritin levels (>500 ng/mL) emerged as an independent prognostic marker for increased mortality (HR = 2.5, 95% CI: 1.3-4.7)

4. DISCUSSION

4.1 Comparative Analysis of Child-Pugh and MELD Scores

“The Child-Pugh score, initially designed to predict surgical mortality in cirrhotic patients, remains a reliable tool for assessing liver disease severity and prognosis” [6]. “This scoring system incorporates five clinical measures: encephalopathy, ascites, bilirubin, albumin, and prothrombin time/international normalized ratio (INR). Patients are classified into three classes (A, B, and C) based on the total score” [7]. “In this study, survival rates for Child-Pugh classes A, B, and C were 100%, 80%, and 45%, respectively, demonstrating its utility in predicting short-term mortality” [8].

“The MELD score, based on a mathematical formula incorporating bilirubin, creatinine, and INR, was initially developed to predict mortality in patients undergoing transjugular intrahepatic portosystemic shunt (TIPS) procedures. Although the MELD score demonstrated high sensitivity in identifying patients at risk of poor outcomes, its overall predictive accuracy was slightly lower than that of the Child-Pugh score for short-term mortality” [9].

Table 3. Presenting clinical manifestations in patients at the time of admission

Clinical signs/symptoms at presentation	Prevalence (n)	Prevalence (%)
Hepatic encephalopathy	8	16
Ascites	19	38
Jaundice	46	94
Malena	8	16
Hematemesis	8	16

4.2 Prognostic Value of Serum Ferritin

“Serum ferritin, an acute-phase reactant and marker of iron stores, has been explored as a potential prognostic marker in various liver diseases. Elevated ferritin levels indicate increased hepatic iron deposition, inflammation, and oxidative stress, contributing to liver injury and fibrosis progression” [10,11]. In this study, patients with serum ferritin levels >500 ng/mL had significantly lower survival rates (61%) compared to those with levels <500 ng/mL (88%), underscoring ferritin's potential role as an independent prognostic marker.

Clinical Implications and Future Directions: This study's findings have profound implications for liver cirrhosis management, highlighting the importance of:

Clinical Applications:

1. Integrated Risk Stratification: Combining Child-Pugh and MELD scores to predict disease severity and short-term mortality.
2. Serum Ferritin Surveillance: Regular monitoring to identify high-risk patients and guide timely interventions.

3. Personalized Treatment Approaches: Integrating clinical scoring systems and biomarkers for tailored management.
4. Informed Liver Transplant Prioritization: Utilizing MELD scores to allocate organs to patients with the highest mortality risk.
5. Novel Biomarker Development: Encouraging research into innovative biomarkers to enhance predictive accuracy.

Future Research Directions:

To further optimize liver cirrhosis management:

1. Large-Scale Validation Studies: Multicenter investigations to confirm these findings and explore underlying mechanisms.
2. Biomarker Discovery: Identifying novel biomarkers to complement existing scoring systems.
3. Advanced Imaging Integration: Leveraging MRI and CT scans to improve predictive accuracy.
4. Targeted Therapeutic Interventions: Exploring treatments like iron chelation therapy for patients with elevated serum ferritin levels.

Implementation and Impact:

By adopting these recommendations, clinicians can

- Enhance liver cirrhosis management
- Improve patient outcomes
- Reduce healthcare costs

This study's findings and proposed future directions aim to transform liver cirrhosis care, ensuring more effective and personalized treatment strategies.

5. CONCLUSION

This prospective observational study investigated the predictive accuracy of Child-Pugh and MELD scores in patients with liver cirrhosis and evaluated the prognostic value of serum ferritin levels. The findings demonstrate:

1. Child-Pugh score remains a reliable tool for assessing disease severity and predicting short-term mortality in liver cirrhosis.
2. MELD score is useful for identifying patients at high risk of poor outcomes.
3. Elevated serum ferritin levels (>500 ng/mL) are associated with significantly lower survival rates and poor prognosis.

These results underscore the importance of integrating clinical scoring systems and biomarkers to enhance predictive accuracy and guide therapeutic decision-making in liver cirrhosis management.

6. LIMITATIONS

This study has several limitations. Firstly, the sample size was relatively small (n = 50), which may limit the generalizability of our findings. Secondly, the study's observational design may introduce bias, and future randomized controlled trials are needed to confirm our results. Additionally, we only assessed serum ferritin levels at a single time point, and longitudinal measurements may provide more insight into its prognostic value.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

CONSENT AND ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Board (IRB) and informed consent was secured from all participants prior to enrollment.

DECLARATION

The study is part of the dissertation entitled “Correlation of Serum Ferritin with Child Pugh Score AND Model for End Stage Liver Disease (Meld) in Chronic Liver Disease” and is a bonafide research work done by Dr. Narendra Dev Yadav in partial fulfillment of the requirement for the degree of Doctor of Medicine. The work has been conducted in Post Graduate Department of Medicine, NSCB Subharti Medical College & associated Chhatrapati Shivaji Subharti Hospital, Meerut under our supervision and guidance OF PROF. (Dr.) PK Gupta AND Dr. Shirobhi Sharma.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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