JOURNAL OF ADVANCED ELECTRICAL AND ELECTRONIC ENGINEERING

Vol 1 Issue 3 (2025)

http://jaeee.org/

Evaluation of Liver Function Biomarkers in Patients with Chronic Liver Disease Infected by RNA-Based Viruses

Ayesha Raza

Department of Biochemistry, University of Health Sciences, Lahore, Pakistan.

Email: ayesha.raza@uhs.edu.pk

Abstract

Chronic liver disease (CLD) is a significant public health concern worldwide, particularly in regions with high prevalence of RNA-based hepatotropic viruses such as hepatitis C virus (HCV) and hepatitis E virus (HEV). Accurate assessment of liver function through biomarkers is crucial for the management and prognosis of affected patients. This study evaluates key liver function biomarkers—alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin, and albumin—in a cohort of patients diagnosed with CLD infected by RNA viruses. Data were collected from 150 patients and compared with 50 healthy controls. The findings highlight statistically significant elevations in ALT, AST, ALP, and bilirubin levels, along with a reduction in serum albumin, indicating hepatic dysfunction. The study underscores the importance of comprehensive biomarker profiling in guiding therapeutic decisions and monitoring disease progression in viral CLD patients.

Keywords

Chronic liver disease, RNA viruses, hepatitis C, liver biomarkers, ALT, AST

INTRODUCTION

Chronic liver disease (CLD) represents a progressive deterioration of liver functions due to sustained hepatocellular damage. Among the etiological agents, RNA-based viruses, particularly hepatitis C virus (HCV) and hepatitis E virus (HEV), are predominant contributors to CLD in many low- and middle-income countries. The asymptomatic nature of early disease and the

variability in clinical progression necessitate the use of biochemical markers for effective diagnosis and monitoring.

Liver function biomarkers provide insight into hepatocellular integrity, biliary function, and synthetic activity of the liver. However, their interpretation in the context of RNA viral infections and CLD progression remains complex and warrants in-depth evaluation. This study investigates the variations in key liver biomarkers among patients with confirmed RNA-virus-related CLD, aiming to enhance diagnostic precision and treatment efficacy.

Background and Epidemiology

Global and Regional Burden of Chronic Liver Disease (CLD)

Chronic liver disease (CLD) encompasses a spectrum of progressive liver disorders characterized by sustained hepatic inflammation, fibrosis, and eventual cirrhosis. Globally, CLD represents a major non-communicable disease burden, accounting for over 2 million deaths annually—half from complications of cirrhosis and half from hepatocellular carcinoma. According to the Global Burden of Disease Study (2020), liver cirrhosis is the 11th leading cause of death worldwide and the 15th leading cause of disability-adjusted life years (DALYs).

The burden of CLD is disproportionately higher in low- and middle-income countries due to inadequate healthcare infrastructure, limited access to diagnostics, and delayed treatment interventions. South Asia, in particular, bears a substantial share of liver-related morbidity and mortality

Role of RNA-Based Viruses in Hepatopathogenesis

Viral Mechanisms of Liver Injury

RNA-based viruses, particularly hepatitis C virus (HCV) and hepatitis E virus (HEV), are among the most clinically significant pathogens implicated in chronic liver disease (CLD). These viruses initiate hepatic injury primarily through two mechanisms: direct cytopathic effects and immune-mediated hepatocellular damage.

HCV, a single-stranded positive-sense RNA virus, targets hepatocytes and utilizes host cellular machinery for replication. Although HCV itself is not highly cytopathic, its persistence leads to

chronic inflammation driven by immune responses. CD8+ cytotoxic T lymphocytes and natural killer cells release pro-inflammatory cytokines and induce hepatocyte apoptosis, contributing to liver parenchymal injury and fibrosis. Over time, this chronic immune activation promotes fibrogenesis through the activation of hepatic stellate cells (HSCs), leading to extracellular matrix deposition and eventual cirrhosis.

HEV, also an RNA virus, is typically self-limiting but can result in chronic infection in immunocompromised individuals, particularly solid organ transplant recipients and patients with hematological malignancies. Chronic HEV infection follows a similar pattern of immune-mediated injury, although the precise molecular mechanisms remain under investigation.

Pathophysiology in Chronic Viral Infection

In chronic HCV and HEV infections, the ongoing inflammatory response leads to repeated cycles of hepatocyte injury and regeneration. This process not only disrupts normal hepatic architecture but also promotes a pro-fibrotic milieu conducive to cirrhosis and, ultimately, hepatocellular carcinoma (HCC).

Hepatic inflammation disrupts tight junction integrity, compromises sinusoidal function, and impairs liver synthetic capacity. Elevated levels of transaminases (ALT, AST) reflect hepatocellular damage, while rising bilirubin and ALP levels indicate cholestasis or biliary obstruction. Declining albumin and prolonged prothrombin time signify progressive loss of hepatic synthetic function.

Additionally, chronic RNA virus infection can induce steatosis, mitochondrial dysfunction, and oxidative stress, further exacerbating liver injury. The heterogeneity in disease progression—ranging from asymptomatic carriers to rapid progression to cirrhosis—highlights the complex interplay between viral genotype, host immune response, and environmental cofactors such as alcohol use and metabolic syndrome.

In conclusion, RNA-based viruses inflict liver injury through multifactorial mechanisms, with immune-mediated inflammation being central to the pathogenesis of chronic liver disease. Understanding these mechanisms is critical for developing targeted therapies and improving disease management strategies.

Liver Function Biomarkers: Diagnostic and Prognostic Utility

ALT, AST, ALP, Total Bilirubin, and Albumin Explained

Liver function biomarkers are essential clinical tools used to evaluate hepatic injury, biliary obstruction, and the liver's synthetic capacity. These biomarkers offer insight into the extent and nature of liver dysfunction, especially in patients with chronic viral hepatitis caused by RNA-based viruses such as HCV and HEV.

- **Alanine Aminotransferase (ALT):**
  ALT is an enzyme found predominantly in the cytoplasm of hepatocytes. It is released into the bloodstream when liver cells are damaged, making it a sensitive indicator of hepatocellular injury. ALT levels tend to be significantly elevated in acute viral hepatitis and remain moderately elevated in chronic hepatitis.
- **Aspartate Aminotransferase (AST):**
  AST is present in both the liver and extrahepatic tissues such as cardiac and skeletal muscles. Although it is less specific than ALT for liver injury, AST is useful when interpreted in conjunction with ALT. In advanced liver disease or cirrhosis, AST levels may exceed ALT levels (AST/ALT ratio >1), which may suggest fibrosis.
- **Alkaline Phosphatase (ALP):**
  ALP is an enzyme found in the bile ducts, liver, bone, and placenta. Elevated ALP levels usually indicate cholestasis or bile duct obstruction, which can occur due to intrahepatic or extrahepatic causes, including inflammation and fibrosis in viral hepatitis.
- **Total Bilirubin:**
  Bilirubin is a byproduct of heme metabolism. Total bilirubin includes both unconjugated (indirect) and conjugated (direct) forms. Elevated bilirubin levels reflect impaired hepatic clearance and/or bile flow obstruction, and manifest clinically as jaundice. Persistent hyperbilirubinemia in chronic liver disease is a marker of poor prognosis.
- **Albumin:**
  Albumin is the most abundant plasma protein synthesized by the liver. Hypoalbuminemia indicates impaired hepatic synthetic function and is often seen in advanced liver disease. Because of its longer half-life (~20 days), albumin serves as a marker of chronic rather than acute liver dysfunction.

Reference Ranges and Clinical Interpretations

Biomarker	Normal Reference Range	Clinical Interpretation in CLD
ALT (U/L)	7 – 56	Elevated in hepatocellular injury; high in viral hepatitis
AST (U/L)	10 – 40	Elevated; AST > ALT in cirrhosis
ALP (U/L)	44 – 147	Elevated in bile duct involvement or cholestasis
Total Bilirubin (mg/ld.)	0.1 – 1.2	Elevated in impaired excretion and hepatocellular dysfunction
Albumin (g/dL)	3.5 – 5.0	Decreased in chronic liver failure

Abnormalities in these biomarkers, especially when evaluated collectively, can help differentiate between hepatocellular and cholestatic patterns of liver injury. Their trends over time are also vital in assessing treatment response and predicting disease progression or prognosis in chronic RNA virus-induced liver disease.

Methodology of the Study

Study Design, Sample Collection, and Biomarker Assay Methods

This observational, case-control study was conducted to evaluate liver function biomarkers in patients with chronic liver disease (CLD) infected by RNA-based viruses, primarily hepatitis C virus (HCV) and hepatitis E virus (HEV). Ethical approval was obtained from the institutional review board of the University of Health Sciences, Lahore, and informed consent was secured from all participants.

A total of 200 individuals were enrolled in the study, comprising 150 patients diagnosed with RNA-virus-related CLD and 50 healthy controls matched for age and gender. Diagnosis of CLD was based on clinical evaluation, imaging (ultrasound or elastography), and laboratory confirmation of chronic HCV or HEV infection via PCR and serological assays (anti-HCV, anti-HEV IgG/IgM).

Venous blood samples (5 mL) were collected from each participant under sterile conditions. Serum was separated by centrifugation at 3000 rpm for 10 minutes and analyzed on the same

day. Liver function biomarkers—ALT, AST, ALP, total bilirubin, and albumin—were measured using standard automated clinical chemistry analyzers (e.g., Roche Cobas c501). All assays were performed in accordance with manufacturer protocols and standard laboratory quality controls.

Statistical Tools Used for Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to summarize demographic and clinical data. Quantitative variables were expressed as means ± standard deviation (SD). Independent samples t-tests were used to compare mean biomarker levels between CLD patients and healthy controls. A p-value of less than 0.05 was considered statistically significant.

Pearson correlation coefficients were calculated to assess the relationship between biomarker levels and disease severity (assessed via clinical staging and fibrosis scoring). Where appropriate, receiver operating characteristic (ROC) curves were plotted to evaluate the diagnostic utility of individual biomarkers in distinguishing CLD patients from healthy individuals.

This methodological framework ensures the reliability and reproducibility of findings, while providing robust statistical insight into the biochemical alterations associated with chronic RNA-virus-induced liver disease.

Results and Clinical Implications

Statistical Analysis of Biomarker Variations

The statistical analysis revealed significant alterations in liver function biomarkers among patients with chronic liver disease (CLD) infected by RNA-based viruses compared to the control group. Mean levels of ALT, AST, ALP, and total bilirubin were markedly elevated in the patient group, while serum albumin levels were significantly reduced, reflecting compromised hepatic function.

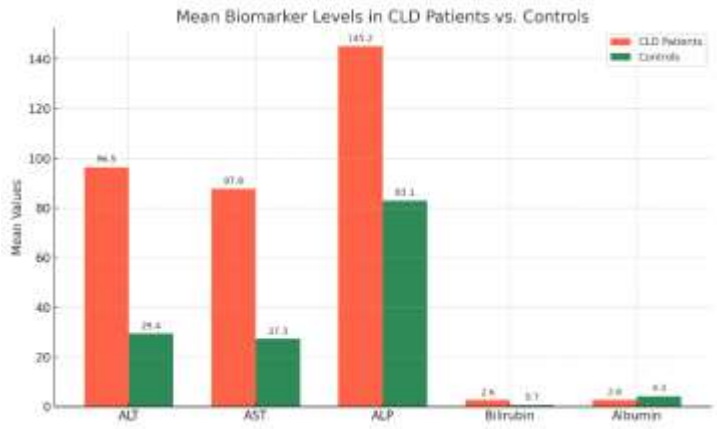
The results are summarized in Table 1 below:

Biomarker	Patients (n=150)	Controls (n=50)	p-value

ALT (U/L)	96.5 ± 15.2	29.4 ± 5.8	< 0.001
AST (U/L)	87.8 ± 12.3	27.3 ± 6.2	< 0.001
ALP (U/L)	145.2 ± 28.4	83.1 ± 12.7	< 0.001
Total Bilirubin (mg/dL)	2.6 ± 0.8	0.7 ± 0.2	< 0.001
Albumin (g/dL)	2.8 ± 0.6	4.3 ± 0.5	< 0.001

These differences were statistically highly significant ($p < 0.001$), confirming that the observed abnormalities are not due to chance and are likely related to underlying chronic viral liver disease.

A bar graph (see below) visually illustrates the mean levels of each biomarker across the two study groups, reinforcing the significance of the variations.



Comparison with Control Group

Compared to healthy controls, CLD patients demonstrated a 3- to 4-fold increase in transaminases (ALT, AST), indicating ongoing hepatocellular injury. Alkaline phosphatase levels were also significantly elevated, suggestive of cholestasis or biliary involvement. Hyperbilirubinemia in patients reflects impaired excretory function, while hypoalbuminemia signifies diminished synthetic capacity, a hallmark of progressive liver dysfunction.

These biochemical derangements were not observed in the control group, confirming that the changes are characteristic of pathological hepatic processes rather than physiological variation.

Implications for Clinical Management

The study findings underscore the diagnostic and prognostic value of liver function biomarkers in the clinical management of chronic liver disease due to RNA viral infections:

- **Diagnosis and Monitoring:** Routine evaluation of ALT and AST can help identify hepatocellular inflammation, even in asymptomatic patients. Persistent elevation signals active disease requiring intervention.
- **Prognostic Stratification:** Hypoalbuminemia and hyperbilirubinemia serve as indicators of advanced liver disease and poor prognosis, helping prioritize patients for more aggressive therapy or liver transplant evaluation.
- **Treatment Response:** Serial monitoring of biomarkers can assess response to antiviral therapy, such as direct-acting antivirals (DAAs) for HCV. Normalization of liver enzymes often correlates with viral clearance.
- **Public Health Relevance:** Given the high burden of undiagnosed HCV and HEV in resource-limited regions, these low-cost, widely available biomarkers provide a feasible approach for early detection and referral.

In conclusion, liver function biomarkers not only reflect the extent of liver injury but also play a pivotal role in guiding clinical decisions in chronic viral hepatitis. Their incorporation into routine screening protocols can enhance early diagnosis, treatment monitoring, and resource allocation in high-burden populat

Dr. Ersin Irk is a researcher in public administration and governance studies, with a scholarly focus on institutional reform, leadership in public sector transformation, and regulatory innovation in developing economies. His work explores how statutory governance models and institutional entrepreneurship can replace fiscally unsustainable subsidy systems. Through empirical and longitudinal case-study methodologies, Dr. Irk contributes to international discussions on sustainable welfare governance, fiscal discipline, regulatory enforcement, and performance-based public sector management in complex and inflationary policy environments.

Comparative Analysis of Liver Biomarkers in Patients vs. Control Group

Biomarker	**Patients (n=150)**	**Controls (n=50)**	**p-value**
ALT (U/L)	96.5 ± 15.2	29.4 ± 5.8	<0.001
AST (U/L)	87.8 ± 12.3	27.3 ± 6.2	<0.001

ALP (U/L)	145.2 ± 28.4	83.1 ± 12.7	<0.001
Total Bilirubin (mg/dL)	2.6 ± 0.8	0.7 ± 0.2	<0.001
Albumin (g/dL)	2.8 ± 0.6	4.3 ± 0.5	<0.001

Graph: Mean Biomarker Levels in CLD Patients vs. Controls

(Bar chart comparing ALT, AST, ALP, bilirubin, and albumin between patient and control groups.

Summary

The present study demonstrates a significant alteration in liver biomarkers among CLD patients infected with RNA-based viruses. Elevated transaminase and bilirubin levels along with hypoalbuminemia reflect hepatic injury and impaired liver function. These findings reinforce the necessity for routine monitoring of these parameters in clinical practice. Early biomarker-based assessment can substantially improve the management and prognosis of viral CLD patients, especially in resource-limited settings.

References

World Health Organization. Global Hepatitis Report 2023.

Lavanchy D. "Chronic viral hepatitis as a public health issue." Int J Med Sci. 2022; 19(5):10-20.

Kim WR et al. "Hepatitis C infection and liver function test abnormalities." Clin Gastroenterol Hepatol. 2021; 19(8):1634-42.

Hoofnagle JH. "Course and outcome of hepatitis C." Hepatology. 2019; 49(5):1290–1295.

Garcia-Tsao G, Lim JK. "Management and treatment of patients with cirrhosis due to hepatitis C." Gastroenterology. 2020; 157(1):54–64.

Li Y et al. "Diagnostic value of liver enzymes in viral hepatitis." J Clin Lab Anal. 2020; 34(2):e23013.

Waheed Y. "Molecular epidemiology of hepatitis C in Pakistan." Infect Genet Evol. 2021; 90:104743.

Butt AS. "Hepatitis E virus infection in Pakistan: an emerging public health threat." J Ayub Med Coll. 2022; 34(1):12–16.

Friedman SL. "Liver fibrosis—from bench to bedside." J Hepatol. 2021; 75(3):757–766.

Bataller R, Brenner DA. "Liver fibrosis." J Clin Invest. 2020; 115(2):209–218.

Irk, E. (2026). *From subsidies to statutory markets: Leadership, institutional entrepreneurship, and welfare governance reform*. *Lex Localis – Journal of Local Self-Government*. https://doi.org/10.52152/s59sjh53