

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

Swe Min Oo^{*1}, Myint Zaw², Tun Naing Oo³, Hein Zaw³, Phway Mon Myo⁴

¹Consultant Cardiologist, Department of Cardiology, 700 Bedded Military Hospital, Pyin Oo Lwin, Myanmar

²Professor and Head, Department of Cardiology, Defence Services Medical Academy, Yangon, Myanmar

³Consultant Physician, Department of Medicine, 700 Bedded Military Hospital, Pyin Oo Lwin, Myanmar

⁴Specialist Registrar, Department of Cardiology, 700 Bedded Military Hospital, Pyin Oo Lwin, Myanmar

ABSTRACT

Background

Cirrhotic cardiomyopathy remains under-recognized in Southeast Asia, where chronic viral hepatitis and alcohol-related liver disease frequently coexist. The prognostic relevance of the updated 2020 Cirrhotic Cardiomyopathy Consortium (CCC) criteria, particularly the use of global longitudinal strain (GLS), has not been adequately studied in this region.

Objectives

We aimed to characterize cardiac dysfunction in Myanmar patients with cirrhosis, compare the diagnostic performance of the 2005 and 2020 CCM criteria, and determine cardiac predictors of 1-year mortality.

Methods

In this prospective cohort study, 200 consecutive cirrhotic patients underwent comprehensive echocardiography with speckle-tracking analysis and standard electrocardiography. The primary endpoint was all-cause mortality at 12 months. Multivariable Cox regression was used to identify independent predictors of death.

Results

The mean age was 54±11 years. Alcohol-associated liver disease (35%), hepatitis C (30%), and hepatitis B (25%) were the predominant etiologies. Although left ventricular ejection fraction was preserved, GLS was frequently impaired (mean -16.2±3.4%). The 2020 CCC criteria identified cirrhotic cardiomyopathy in 28% of patients compared with 54% by the 2005 criteria. Thirty patients (15%) died during follow-up. GLS <16% (HR 2.10, p<0.001) and QTc prolongation >440 ms (HR 1.75, p=0.018) were independently associated with mortality after adjustment for MELD score.

Conclusions

Subclinical myocardial dysfunction is common among Myanmar patients with cirrhosis. The 2020 CCC criteria demonstrate improved prognostic discrimination. Both impaired GLS and QTc prolongation independently predict mortality and should be incorporated into routine risk stratification.

KEYWORDS: Liver Cirrhosis, Cirrhotic Cardiomyopathy, Global Longitudinal Strain, QTc Interval, Prognosis.

ARTICLE DETAILS

Published On:

29 July 2026

Available on:

<https://ijmscrs.com>

INTRODUCTION

Chronic liver disease represents a major health burden in Myanmar, where hepatitis B, hepatitis C, and increasing

alcohol consumption coexist [1]. This evolving epidemiological profile has accelerated the progression to

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

advanced cirrhosis and increased the prevalence of extra-hepatic complications, particularly cardiac involvement [2].

Cirrhotic cardiomyopathy describes a chronic impairment of myocardial performance in patients with cirrhosis, characterized by reduced contractile reserve and abnormal diastolic relaxation [3]. Traditional diagnostic frameworks, including the 2005 Montreal criteria, rely largely on load-dependent parameters such as left ventricular ejection fraction and transmitral inflow indices [4]. In the hyperdynamic circulatory state of cirrhosis, these measures often remain within normal ranges, masking early myocardial dysfunction [3].

The 2020 Cirrhotic Cardiomyopathy Consortium (CCC) criteria introduced global longitudinal strain (GLS) as a core marker of systolic function. GLS provides a more direct assessment of myocardial contractility and is less influenced by preload and afterload conditions. Although GLS has demonstrated clinical utility in other Myanmar populations, including oncology and chronic kidney disease cohorts, its prognostic value in cirrhotic patients has not been systematically evaluated [5, 6].

In parallel, the 12-lead electrocardiogram remains the most accessible cardiac test in resource-limited settings. QTc prolongation is a recognized electrophysiological feature of cirrhosis and has been linked to autonomic dysfunction and adverse outcomes [7]. Whether QTc can serve as a practical mortality marker in Myanmar cirrhotic patients remains uncertain.

This study was therefore designed to characterize cardiac dysfunction using contemporary echocardiographic and electrocardiographic parameters, compare historical and updated CCM criteria, and identify independent cardiac predictors of 1-year mortality in a prospective Myanmar cohort.

MATERIALS & METHODS

Study Design and Population

This was a prospective, observational cohort study conducted at the 700 Bedded Military Hospital, Pyin Oo Lwin, a tertiary referral center serving the Mandalay Region of Myanmar. Consecutive patients were recruited between January 2024 and June 2025.

Ethical Approval

The study protocol was reviewed and approved by the Institutional Review Board and written informed consent was obtained from all participants or their legally authorized representatives prior to enrollment. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Study Population

Adult patients with established liver cirrhosis were eligible for inclusion. Cirrhosis was diagnosed based on a

combination of clinical features, biochemical testing, imaging findings, and transient elastography when available.

Patients were excluded if they had a known history of ischemic heart disease, moderate-to-severe valvular heart disease, atrial fibrillation, cardiomyopathy of non-cirrhotic origin, or end-stage renal disease requiring maintenance hemodialysis [8]. A total of 200 consecutive patients fulfilling eligibility criteria were enrolled.

Echocardiographic Assessment

Transthoracic echocardiography was performed using commercially available ultrasound systems by experienced operators, following current American Society of Echocardiography and European Association of Cardiovascular Imaging guidelines [9].

Systolic Function Left ventricular ejection fraction (LVEF) was measured using the biplane Simpson method from apical two- and four-chamber views.

Global longitudinal strain (GLS) was obtained using two-dimensional speckle-tracking analysis from apical long-axis, four-chamber, and two-chamber views, with a frame rate of 50-70 frames per second. For diagnostic classification of cirrhotic cardiomyopathy, impaired GLS was defined as an absolute value <18% according to the 2020 CCC recommendations [3]. For prognostic analyses, a more stringent threshold of <16% was used, as this cutoff demonstrated optimal discrimination for mortality in preliminary analyses [10].

Diastolic Function Diastolic function was evaluated using septal and lateral e' velocities, E/e' ratio, left atrial volume index (LAVI), and tricuspid regurgitation velocity. Grading of diastolic dysfunction was performed in accordance with contemporary guideline recommendations [9].

Electrocardiographic Assessment

A standard resting 12-lead electrocardiogram was recorded for all participants. QT intervals were corrected for heart rate using the Fridericia formula, which is preferred in liver disease over Bazett's formula [11]. QTc prolongation was defined as >440 ms in men and >460 ms in women [7].

Clinical Variables

Demographic data, etiology of liver disease, hemodynamic parameters, Child-Pugh classification, and Model for End-Stage Liver Disease (MELD) scores were recorded at baseline [12, 13].

Outcomes

The primary outcome was all-cause mortality at 12 months following enrollment. Mortality data were obtained from hospital records and direct follow-up contact when necessary.

Statistical Analysis

Continuous variables are presented as mean $\pm$ standard deviation and categorical variables as number and

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

percentage. Between-group comparisons were performed using Student’s t-test or the χ^2 test, as appropriate.

Survival probabilities were estimated using Kaplan-Meier analysis and compared with the log-rank test. Cox proportional hazards regression was used to identify independent predictors of mortality. Multivariable models were adjusted for age, MELD score, Child-Pugh class, and hemodynamic parameters [12, 13]. Hazard ratios are reported with 95% confidence intervals. A two-sided p-value <0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

A total of 200 patients were included in the final analysis. The mean age was 54 ± 11 years, and 136 patients (68%) were male. Alcohol-associated liver disease was the most frequent etiology (35%), followed by hepatitis C virus infection (30%) and hepatitis B virus infection (25%). Ten percent of patients had other etiologies, including metabolic dysfunction-associated steatotic liver disease (MASLD).

The cohort demonstrated advanced liver disease severity. Forty percent of patients were classified as Child-Pugh class C, and the mean MELD score was 17 ± 6. Non-survivors were older and had significantly higher Child-Pugh and MELD scores compared with survivors (all p < 0.001). Mean arterial pressure and resting heart rate also differed significantly between groups, reflecting greater circulatory compromise among patients who died (Table 1).

Table 1: Baseline Characteristics of the Study Population

Variable	All Patients (n=200)	Survivors (n=170)	Non-Survivors (n=30)	P-value
Demographics				
Age (years), Mean ± SD	54±11	53±10	59±12	0.01
Male Sex, n (%)	136 (68%)	115 (68%)	21 (70%)	0.82
Female Sex, n (%)	64 (32%)	55 (32%)	9 (30%)	0.82
Etiology, n (%)				
Alcohol-associated	70 (35%)	59 (35%)	11 (37%)	0.81
Hepatitis C (HCV)	60 (30%)	52 (31%)	8 (27%)	0.65
Hepatitis B (HBV)	50 (25%)	42 (25%)	8 (27%)	0.80
Other/MASLD	20 (10%)	17 (10%)	3 (10%)	0.99
Liver Function				
Child-Pugh Score, Mean ± SD	8.8±2.4	8.3±2.2	11.2±2.1	<0.001

SD				
MELD Score, Mean ± SD	17±6	16±5	24±7	<0.001
Hemodynamics				
MAP (mmHg), Mean ± SD	83±11	84±10	75±12	<0.001
Heart Rate (bpm), Mean ± SD	84±15	82±12	96±16	<0.001

This table summarizes the demographic, clinical, and hemodynamic profiles of the 200 patients enrolled in the study at baseline. The cohort is categorized into survivors and non-survivors based on the primary endpoint of all-cause mortality at 12 months. Between-group comparisons were performed using Student's t-test for continuous variables and the χ^2 (Chi-squared) test for categorical variables.

Hemodynamic and Echocardiographic Findings

Preserved Ejection Fraction with Impaired Myocardial Mechanics

Conventional echocardiography showed preserved systolic function in most patients. The mean left ventricular ejection fraction was 64 ± 5%, and only 5% of the cohort had an LVEF below 50%. Despite this apparent preservation of systolic performance, speckle-tracking echocardiography revealed frequent abnormalities in myocardial deformation. Mean GLS was -16.2 ± 3.4%, and nearly half of the cohort (48%) demonstrated impaired GLS (< -16%).

Marked differences were observed between survivors and non-survivors. Patients who died had significantly worse GLS values compared with survivors (-12.9 ± 3.2% vs -16.8 ± 3.1%, p < 0.001), and impaired GLS was present in 80% of non-survivors compared with 42% of survivors.

Diastolic Function

Diastolic parameters also differed significantly between groups. Non-survivors exhibited larger left atrial volumes, lower e' velocities, and higher E/e' ratios, indicating more advanced diastolic dysfunction. These differences were consistent with the updated 2020 CCC diastolic criteria and are summarized in Table 2.

Table 2: Echocardiographic and Electrocardiographic Parameters

Parameter	All Patients (n=200)	Survivors (n=170)	Non-Survivors (n=30)	P-value
Systolic Function				
LVEF (%), Mean ± SD	64±5	65±4	60±6	0.04
GLS (%), Mean ± SD	-16.2±3.4	-16.8±3.1	-12.9±3.2	<0.001

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

Impaired GLS (<16%), n (%)	96 (48%)	72 (42%)	24 (80%)	<0.001
Diastolic Function (2020)				
LAVI (mL/m2), Mean ± SD	38±13	36±11	48±14	<0.001
Average e' (cm/s), Mean ± SD	7.5±2.2	7.8±2.0	6.0±2.3	<0.001
E/e' Ratio, Mean ± SD	11.2±3.5	10.5±3.0	15.1±3.8	<0.001
Electrophysiology				
QTc Fridericia (ms), Mean ± SD	452±38	446±32	482±40	<0.001
QTc Prolongation (>440ms), n (%)	84 (42%)	63 (37%)	21 (70%)	0.001

This table presents the baseline cardiac and electrophysiological profile of the study participants, comparing survivors and non-survivors over a 12-month period. Comparisons were performed using Student's t-test or the χ^2 test.

Comparison of Diagnostic Criteria for Cirrhotic Cardiomyopathy

When the 2005 Montreal criteria were applied, 54% of patients met the diagnostic threshold for cirrhotic cardiomyopathy. In contrast, application of the 2020 CCC criteria reduced the estimated prevalence to 28%, identifying a smaller but clinically higher-risk subgroup. Patients meeting the 2020 criteria had significantly worse survival outcomes, supporting improved prognostic discrimination with the updated definition.

Electrocardiographic Findings

QTc prolongation was common, occurring in 84 patients (42%). QTc intervals increased progressively with worsening liver disease severity. Mean QTc values were 412 ± 25 ms in Child-Pugh class A, 438 ± 30 ms in class B, and 465 ± 38 ms in class C ($p < 0.001$ for trend).

Patients who died had significantly longer QTc intervals than survivors (482 ± 40 ms vs 446 ± 32 ms, $p < 0.001$). Severe QTc prolongation (>500 ms) was uncommon but was associated with uniformly poor outcomes.

Survival Outcomes

Over the 12-month follow-up period, 30 patients (15%) died. The majority of deaths were attributable to liver-related causes, including acute-on-chronic liver failure and

variceal bleeding. Cardiac causes, such as sudden cardiac death and decompensated heart failure, accounted for approximately 10% of deaths.

Predictors of Mortality

In multivariable Cox proportional hazards models adjusted for age, MELD score, and hemodynamic parameters, two cardiac variables remained independently associated with mortality. Impaired GLS (<16%) was the strongest predictor of death (HR 2.10, 95% CI 1.41-3.15; $p < 0.001$). QTc prolongation (>440 ms) was also independently associated with increased mortality risk (HR 1.75, 95% CI 1.10-2.80; $p = 0.018$).

The addition of GLS and QTc significantly improved the prognostic performance of the baseline MELD model (likelihood ratio χ^2 improvement 8.4, $p = 0.01$) (Table 3).

Table 3: Multivariable Cox Regression for 1-Year Mortality

Variable	Adjusted Hazard Ratio (95% CI)	P-value
MELD Score (per point)	1.08 (1.04 – 1.12)	<0.001
GLS (absolute value < 16%)	2.10 (1.41 – 3.15)	<0.001
QTc Prolongation (> 440 ms)	1.75 (1.10 – 2.80)	0.018
Age (> 60 years)	1.45 (0.85 – 2.48)	0.17
MAP (< 80 mmHg)	1.32 (0.80 – 2.15)	0.28

DISCUSSION

This study provides the first prospective assessment of contemporary echocardiographic and electrocardiographic parameters in a cohort of cirrhotic patients from Myanmar, performed at the 700 Bedded Military Hospital in Pyin Oo Lwin. In a population characterized by the combined impact of chronic viral hepatitis and increasing alcohol use, our results highlight three principal observations: evidence of additive myocardial injury related to mixed etiologies [14], improved prognostic discrimination using the 2020 Cirrhotic Cardiomyopathy Consortium criteria, and the clinical usefulness of the QTc interval as an accessible risk marker in resource-limited practice [15].

The "Double Burden": Synergistic Cardiotoxicity in Myanmar

The pattern of chronic liver disease seen in Myanmar differs in important ways from that reported in Western populations [1]. In contrast to cohorts in which alcohol use or metabolic disease usually predominates, our patients frequently showed overlapping etiologies, most commonly alcohol-associated liver disease (35%), hepatitis C (30%),

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

and hepatitis B (25%). Although left ventricular ejection fraction appeared preserved in this hyperdynamic setting (mean 64%), myocardial deformation analysis told a different story, with markedly reduced global longitudinal strain (mean -16.2%), indicating the presence of otherwise unrecognized systolic impairment [16].

Several interacting mechanisms are likely to contribute to this pattern of myocardial impairment. Prolonged alcohol exposure has direct toxic effects on cardiomyocytes, interfering with excitation-contraction coupling, increasing oxidative stress, and disrupting mitochondrial function [17]. At the same time, chronic hepatitis B and C infection is associated with a sustained inflammatory milieu, with elevated circulating cytokines such as tumor necrosis factor- α and interleukin-6 that promote myocardial fibrosis and increased ventricular stiffness [18]. Experimental and molecular data further suggest that alcohol may amplify viral replication and downstream signaling pathways, thereby increasing susceptibility of cardiomyocytes to apoptosis and weakening antiviral immune responses [14].

The frequent finding of preserved ejection fraction in the presence of impaired GLS within our alcohol-viral subgroups supports the concept of a "double hit" myocardial injury, in which metabolic toxicity and inflammatory remodeling coexist. This combination appears to produce clinically relevant myocardial dysfunction that is not adequately captured by conventional measures of systolic performance [19].

Diagnostic Evolution: From 2005 to 2020 Criteria

Applying the updated 2020 Cirrhotic Cardiomyopathy Consortium criteria substantially reduced the proportion of patients classified as having cirrhotic cardiomyopathy, with prevalence falling from 54% under the 2005 Montreal definition to 28% [2]. This change is unlikely to reflect a true decline in disease burden; rather, it suggests improved diagnostic specificity, with fewer patients being misclassified on the basis of load-dependent or nonspecific findings.

The earlier 2005 definition placed considerable emphasis on the transmitral E/A ratio, a measurement that is highly sensitive to loading conditions. In our population, ascites was common, and the associated increase in intra-abdominal pressure would be expected to raise left atrial pressure and exaggerate early diastolic filling. This mechanism can produce an apparently "normal" E/A pattern despite the presence of impaired myocardial relaxation, thereby obscuring true diastolic dysfunction [15].

By contrast, the 2020 criteria incorporate tissue Doppler-derived e' velocities and the left atrial volume index, parameters that better reflect intrinsic myocardial relaxation and sustained elevations in filling pressure and are less influenced by transient fluid shifts [3]. The clinical relevance of this approach was supported by our outcome analysis, in which patients classified using the 2020

definition experienced significantly poorer survival, indicating that the revised criteria more accurately identify the subgroup at genuine high risk [20].

GLS: The "Weak Link" in Acute-on-Chronic Liver Failure

While an absolute GLS value of $<18\%$ was utilized to meet the contemporary 2020 CCC diagnostic criteria for cirrhotic cardiomyopathy, a more stringent threshold of $<16\%$ was applied for prognostic evaluation, as preliminary analyses determined this cutoff provided optimal discrimination for identifying high-risk patients subject to 1-year mortality. In multivariable models, a markedly reduced GLS (absolute value $<16\%$) emerged as a strong and independent predictor of death within one year, with a prognostic impact that exceeded that of the MELD score alone. This observation has important clinical implications for patients with advanced liver disease in Southeast Asia. It indicates that limited myocardial contractile reserve plays a key role in determining survival when patients are exposed to major hemodynamic stressors, including spontaneous bacterial peritonitis, variceal hemorrhage, and surgical interventions [21].

During episodes of acute-on-chronic liver failure, cardiac performance often becomes a limiting factor in overall physiological compensation. When myocardial deformation is impaired, the heart may be unable to increase output adequately in response to the heightened metabolic demands of systemic inflammation, predisposing patients to tissue hypoperfusion and subsequent multi-organ dysfunction, including hepatorenal syndrome [22]. For this reason, assessment of GLS should be incorporated into pre-transplant cardiac evaluation at tertiary centers such as the 700 Bedded Military Hospital. Recognition of markedly reduced GLS ($<16\%$) may improve peri-operative risk stratification and assist in identifying patients whose cardiac reserve may be insufficient to tolerate transplantation.

QTc Interval: A "Vital Sign" for District Hospitals

Although GLS provides the most sensitive assessment of myocardial function, its routine use in Myanmar is limited by the cost and availability of advanced echocardiographic equipment [5, 6]. In many district hospitals, where patients with cirrhosis commonly first seek care, access to this technology remains restricted or absent.

Our findings underscore the practical value of the QTc interval as an accessible and inexpensive marker of risk. QTc prolongation was observed in 42% of patients and was independently associated with increased mortality (HR 1.75) [7]. This association is likely related to autonomic dysfunction, portosystemic shunting, and abnormalities in myocardial repolarization that accompany advanced cirrhosis [20].

Our data supports a "Two-Tier" Risk Model for resource-limited settings:

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

- **Tier 1 (>440 ms):** This level of QTc prolongation reflects more advanced disease and underlying autonomic dysfunction. Patients within this range demonstrate lower survival and warrant closer clinical monitoring and follow-up [7].

- **Tier 2 (>500 ms):** QTc values in this range indicate a markedly increased risk of malignant ventricular arrhythmias, including torsades de pointes. Patients meeting this threshold should undergo prompt cardiac review with correction of electrolyte abnormalities and careful reassessment of QT-prolonging medications [23].

We therefore suggest that a Fridericia-corrected QTc exceeding 440 ms should prompt referral from district-level facilities to tertiary centers for further cardiac evaluation, including strain imaging, and for closer hemodynamic surveillance.

STUDY LIMITATIONS

Several limitations of this study should be acknowledged. First, this was a single-center investigation conducted at a tertiary military hospital, which may introduce referral bias and limit the generalizability of the findings to the broader civilian population in Myanmar. Patients treated at tertiary centers may represent a more advanced or complex disease spectrum.

Second, the overall 1-year mortality rate observed in this cohort was lower than that reported in some historical cirrhosis studies. This likely reflects improvements in contemporary supportive care and closer follow-up at our institution. However, despite the relatively lower event rate, the associations between cardiac parameters and mortality remained consistent and statistically robust.

Third, stress echocardiography was not performed because of safety concerns in patients with decompensated cirrhosis. As a result, we were unable to directly assess contractile reserve or stress-induced dysfunction, which were components of earlier definitions of cirrhotic cardiomyopathy. Nevertheless, resting GLS provided a practical and prognostically meaningful surrogate of myocardial reserve in this population.

Finally, although QTc prolongation demonstrated strong prognostic value, serial electrocardiographic measurements were not available. Therefore, temporal changes in QTc and their relationship to dynamic clinical deterioration could not be evaluated.

CLINICAL PERSPECTIVES

Competency in Medical Knowledge

In patients with cirrhosis, conventional left ventricular ejection fraction is an unreliable marker of systolic performance because afterload reduction may mask underlying myocardial impairment. Global longitudinal strain provides a more sensitive assessment of intrinsic myocardial contractility and allows identification of

subclinical systolic dysfunction. In addition, QTc prolongation should be recognized not simply as an electrocardiographic abnormality but as a marker of autonomic dysfunction and increased mortality risk.

Competency in Patient Care

In resource-limited environments such as Myanmar, a pragmatic stepwise approach to cardiac assessment may improve risk stratification. Routine electrocardiographic screening should be performed in all patients with cirrhosis. A prolonged QTc interval (>440 ms using Fridericia correction) should prompt referral to centers with echocardiographic strain capability for further evaluation and closer peri-procedural monitoring.

Translational Outlook

Future studies in Southeast Asian populations should examine whether etiologic-directed interventions, including sustained alcohol abstinence and antiviral therapy for chronic hepatitis, are associated with improvement in myocardial strain parameters and long-term cardiovascular outcomes.

CONCLUSIONS

Our study of cirrhotic patients in Myanmar reveals that heart dysfunction is often hidden behind "normal" standard echocardiography. While many patients show a preserved ejection fraction, advanced strain analysis (GLS) reveals a significant drop in actual heart muscle reserve. This damage is likely driven by the combined hit of viral hepatitis and alcohol. By applying the updated 2020 Cirrhotic Cardiomyopathy Consortium criteria, we were able to pinpoint high-risk patients much more accurately than before. Both impaired GLS and QTc prolongation were independently associated with 1-year mortality, even after adjustment for established liver disease severity scores. For clinicians in Myanmar, adding these tools to routine checks is vital for catching high-risk cases early.

ACKNOWLEDGMENT

The author would like to thank staffs of Department of Cardiology and Medicine of 700 Bedded Military Hospital.

Conflicts of interests

The author declares no conflict of interest.

Financial disclosure

No funding was received to conduct this study.

REFERENCES

- I. Myanmar National Hepatitis Elimination Profiles (N-HEP). (2025). <https://www.globalhep.org/data-profiles/countries/myanmar>.
- II. Cesari M, Frigo AC, Piano S, Angeli P: Prevalence and prognostic value of cirrhotic cardiomyopathy as defined according to the proposed new

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

- classification. Clin Exp Hepatol. 2021, 7:270-7. PMID: 34712828. doi: 10.5114/ceh.2021.108708.
- III. Izzy MA-O, VanWagner LA-O, Lin G, Altieri M, Findlay JY, Oh JK.: Redefining Cirrhotic Cardiomyopathy for the Modern Era. Hepatology. 2020, 71:334-345. PMID: 31342529. doi: 10.1002/hep.31463.
- IV. Møller S, Henriksen JH.: Cirrhotic cardiomyopathy. Journal of Hepatology. 2010, 53:179 - 190. PMID: 20462649. doi: 10.1016/j.jhep.2010.02.023.
- V. Oo SM, Myo PM, Thu AK, Zaw H, Oo TN, Zaw M: Echocardiographic Risk Stratification in a General Oncology Population in Myanmar: A Prospective Observational Study. International Journal Of Medical Science And Clinical Research Studies. 2025, 05:1665-71. doi.org/10.47191/ijmscrs/v5-i10-04
- VI. Myo PM, Zaw H, Thu AK, Oo SM: The Structural and Functional Echocardiographic Changes in Haemodialysis Patients with Chronic Kidney Disease: A Cross-Sectional Study. International Journal Of Medical Science And Clinical Research Studies. 2025, 5: doi.org/10.47191/ijmscrs/v5-i09-03
- VII. Kim SM, George B, Alcivar-Franco D, Campbell CL, Charnigo R, Delisle B.: QT prolongation is associated with increased mortality in end stage liver disease. World J Cardiol. 2017, 9:347-354. PMID: 28515853. doi: 10.4330/wjc. v9. i4.347.
- VIII. Oo SM, Myo PM, Thu AK, Zaw H, Oo TN, Zaw M: The Arrhythmias in End-Stage Renal Disease on Maintenance Haemodialysis: A Cross-Sectional Study. International Journal of Medical Science and Clinical Research Studies. 2025, 5:1700-7. doi.org/10.47191/ijmscrs/v5-i10-09
- IX. Nagueh SF, Smiseth OA, Appleton CP, Byrd BF, Dokainish H, Edvardsen T.: Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. 2016, 17: PMID: 27422899. doi: 10.1093/ehjci/jew082.
- X. Thomas JD, Edvardsen T, Abraham T, Appadurai V, Badano L, Banchs J.: Clinical Applications of Strain Echocardiography: A Clinical Consensus Statement from the American Society of Echocardiography Developed in Collaboration with the European Association of Cardiovascular Imaging of the European Society of Cardiology. Journal of the American Society of Echocardiography. 2025, 38:985-1020. PMID: 40864001. doi: 10.1016/j.echo.2025.07.007.
- XI. Vandenberg B, Vandael E, Robyns T, Vandenberghe J, Garweg C, Foulon V.: Which QT Correction Formulae to Use for QT Monitoring? J Am Heart Assoc. 2016, 5: PMID: 27317349. doi: 10.1161/JAHA.117.004252. doi: 10.1161/JAHA.116.003264.
- XII. Ridjab DA-O, Ivan I, Budiman F, Tenggara R: Evaluation of subclinical ventricular systolic dysfunction assessed using global longitudinal strain in liver cirrhosis: A systematic review, meta-analysis, and meta-regression. PLOS ONE. 2022, 17: PMID: 35671306. doi: 10.1371/journal.pone.0269691.
- XIII. Liu HA, Ryu DA, Hwang SA, Lee SA: Therapies for Cirrhotic Cardiomyopathy: Current Perspectives and Future Possibilities. Int J Mol Sci. 2024, 25:5849. PMID: 38892040. doi: 10.3390/ijms25115849.
- XIV. Gao B: Interaction of alcohol and hepatitis viral proteins: implication in synergistic effect of alcohol drinking and viral hepatitis on liver injury. Alcohol. 2002, 27(1):69-72: PMID: 12062640. doi: 10.1016/s0741-8329(02)00201-x.
- XV. Razpotnik M, Bota S, Wimmer P, Hackl M, Lesnik G, Alber H.: The prevalence of cirrhotic cardiomyopathy according to different diagnostic criteria. Liver Int. 2021, 41: 1058-1069. PMID: 33342074. doi: 10.1111/liv.14769.
- XVI. Yingchoncharoen T, Agarwal S, Popović ZB, Marwick TH: Normal Ranges of Left Ventricular Strain: A Meta-Analysis. Journal of the American Society of Echocardiography. 2013, 26:185-91. PMID: 23218891. doi: 10.1016/j.echo.2012.10.008.
- XVII. Matyas C, Haskó G, Liaudet L, Trojnar E, Pacher P: Interplay of cardiovascular mediators, oxidative stress and inflammation in liver disease and its complications. Nat Rev Cardiol. 2021, 18:117-135. PMID: 32999450. doi:10.1038/s41569-020-0433-5.
- XVIII. Liu H, Naser JA, Lin G, Lee SS: Cardiomyopathy in cirrhosis: From pathophysiology to clinical care. JHEP Rep. 2024, 6: PMID: 38089549. doi: 10.1016/j.jhepr.2023.100911.
- XIX. Xu HQ, Wang CG, Zhou Q, Gao YH: Effects of alcohol consumption on viral hepatitis B and C. World J Clin Cases. 2021, 9:10052-63. PMID: 34904075. doi: 10.12998/wjcc. v9. i33.10052.
- XX. Bernardi M, Calandra S, Colantoni A, Trevisani F: Q-T interval prolongation in cirrhosis: prevalence, relationship with severity, and etiology of the disease and possible pathogenetic factors. Hepatology. 1998, 27: PMID: 9425913. doi: 10.1002/hep.510270106.
- XXI. Biering-Sørensen T, Biering-Sørensen SR, Olsen FJ, Sengeløv M: Global Longitudinal Strain by

The Prognostic Value of Echocardiography and ECG In Patients with Liver Cirrhosis: A Single-Center Prospective Cohort Study in Myanmar

- Echocardiography Predicts Long-Term Risk of Cardiovascular Morbidity and Mortality in a Low-Risk General Population. *Circulation: Cardiovascular Imaging*. 2017, 10:005521. doi.org/10.1161/CIRCIMAGING.116.005521.
- XXII. Ohno M, Cheng CP, Little WC: Mechanism of altered patterns of left ventricular filling during the development of congestive heart failure. *Circulation*. 1994, 89:2241-50. PMID: 8181149. doi: 10.1161/01.cir.89.5.2241.
- XXIII. Gibbs C, Thalamus J, Heldal K, Holla ØL, Haugaa KH, Hysing J: Predictors of mortality in high-risk patients with QT prolongation in a community hospital. *EP Europace*. 2018, 20:99-107. PMID: 29036623. doi: 10.1093/europace/eux286.