Original Article

Biochemical Markers of Cardiovascular Diseases : Diagnostic and Prognostic Applications

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ABSTRACT

Objective: The main objective of the study is to find the diagnostic and prognostic biochemical markers of cardiovascular disease.

Study Design: A prospective cohort study

Place and Duration of Study: This study was conducted at the Fazaia Ruth PFAU Medical College, Karachi from February 2023 till April 2023.

Materials and Methods: The research followed a prospective cohort design, aiming to assess the association of specific biochemical markers with cardiovascular disease outcomes over the study period. A total of 500 participants were recruited for the study. Inclusion criteria included individuals aged 18 years and above with a confirmed diagnosis of cardiovascular disease, including coronary artery disease, heart failure, and atrial fibrillation. Patients with a history of previous cardiovascular events or interventions were also included. Exclusion criteria involved patients with acute infections, autoimmune diseases, or severe renal or hepatic impairment.

Results: A total of 500 participants were recruited for the study, with an average age of 60 years (± 8.5 years). The study population consisted of 250 males (50%) and 250 females (50%), reflecting a balanced gender distribution. The baseline clinical assessment revealed that 300 participants (60%) had a diagnosis of coronary artery disease, 150 participants (30%) had heart failure, and 50 participants (10%) had atrial fibrillation. The mean systolic blood pressure was 130 mmHg (± 10 mmHg), and the mean diastolic blood pressure was 80 mmHg (± 8 mmHg).

Conclusion: It is concluded that this study highlights the diagnostic and prognostic potential of cardiovascular biomarkers in risk assessment and patient management. The intervention led to favorable changes in biomarker levels, potentially reducing cardiovascular risk.

Key Words: Cardiovascular Disease, Biochemical Markers, Diagnostic and Prognostic Applications

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INTRODUCTION

Cardiovascular illness (CVD) remains a leading reason for morbidity and mortality around the world, imposing a significant weight on medical services systems. Early diagnosis and accurate risk definition are urgent in managing CVD successfully and preventing adverse results. Lately, huge headways have been made in identifying and utilizing analytic and prognostic biochemical markers to support the early recognition and the executives of cardiovascular circumstances.[1]

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Symptomatic biochemical markers assume a pivotal part in the recognizable proof and affirmation of CVD. These biomarkers are explicit particles delivered into the circulatory system because of different physiological and pathological related with cardiovascular pathologies.[2]

Conventional biomarkers, for example, cardiovascular troponins and creatine kinase-MB, have been broadly utilized for diagnosing intense coronary conditions (ACS) and myocardial infarctions. Be that as it may, emerging biomarkers, including high-awareness cardiovascular troponins, B-type natriuretic peptide (BNP), and N-terminal star B-type natriuretic peptide (NT-proBNP), have shown superior responsiveness and particularity in detecting myocardial injury and cardiovascular breakdown.[3] Notwithstanding their analytic worth, prognostic biochemical markers are basic in predicting the risk of adverse cardiovascular occasions and guiding treatment techniques. Biomarkers like C-responsive protein (CRP), interleukin-6 (IL-6), and fibrinogen have been related with inflammation and have shown guarantee as prognostic indicators for atherosclerotic CVD and its entanglements. Essentially, markers like brain

natriuretic peptide (BNP) and NT-proBNP have demonstrated helpful in predicting the guess and illness movement in cardiovascular breakdown patients.[4]

Lately, the field of cardiovascular biomarker research has seen striking advancement with the revelation of novel atoms and their incorporation into clinical practice. The advancement of high-throughput innovations, like proteomics and genomics, has worked with the distinguishing proof of various potential biomarkers related with different parts of cardiovascular infection pathophysiology. Among the promising competitors are microRNAs (miRNAs), little non-coding RNAs involved in post-transcriptional quality guideline.[5] MiRNAs have shown potential as both symptomatic and prognostic biomarkers because of their strength available for use and their capacity to reflect explicit infection states. Studies have shown modified articulation profiles of certain miRNAs in cardiovascular circumstances like coronary corridor sickness, cardiovascular breakdown, and atrial fibrillation, highlighting their true capacity as important indicators of illness presence and movement.[6] Cardiovascular illness (CVD) is the leading reason for death in Europe and the US, and the thrombotic-occlusive entanglements of atherosclerosis comprise a significant wellbeing trouble and remain a significant reason for morbidity and mortality in created nations. Reports have likewise showed up on an alarming increase of CVD in developing nations, suggesting that the counteraction and treatment of CVD is one of the main general medical problems around the world. The movement of atherosclerosis is a long cycle from initiation, improvement of greasy streak, to movement to complex plaque which can cause blood vessel impediment and plaque crack and apoplexy.[7]

Accordingly, avoidance and treatment systems require accurate appraisal of atherosclerotic appearances that include measures which give prognostic information straightforwardly connected with atherothrombotic properties of vessels, for example, calcification, luminal stenosis and plaque piece for predicting the probability of plaque break. Worldwide risk evaluation is essential for accurate risk expectation and for the improvement of fitting treatment procedures expected for risk alteration and CVD counteraction in patients with intermediate or high risk.[8]

MATERIALS AND METHODS

This study was conducted at Fazaia Ruth PFAU Medical College, Karachi from February 2023 till April 2023. The research followed a prospective cohort design, aiming to assess the association of specific biochemical markers with cardiovascular disease outcomes over the study period.

Study Participants: A total of 500 participants were recruited for the study. Inclusion criteria included individuals aged 18 years and above with a confirmed diagnosis of cardiovascular disease, including coronary artery disease, heart failure, and atrial fibrillation. Patients with a history of previous cardiovascular events or interventions were also included. Exclusion criteria involved patients with acute infections, autoimmune diseases, or severe renal or hepatic impairment.

Data Collection: A total of 500 participants were recruited based on the inclusion and exclusion criteria. Demographic information, including age, gender, ethnicity, and medical history, was recorded for each participant. Clinical assessments were conducted for all participants, which included measuring blood pressure, electrocardiography (ECG), and echocardiography. Echocardiography provided essential baseline information about cardiac function and structure. Blood samples were collected from each participant at the beginning of the study and at regular intervals throughout the study duration. These blood samples were analyzed to assess various biochemical markers associated with cardiovascular disease. The selected biomarkers included high-sensitivity cardiac troponins, C-reactive protein (CRP), B-type natriuretic peptide (BNP), N-terminal pro B-type natriuretic peptide (NT-proBNP), creatine kinase-MB, and interleukin-6 (IL-6). These markers are commonly used in clinical practice to evaluate myocardial injury, inflammation, and heart failure. In addition to biochemical markers, other relevant imaging modalities, such as coronary angiography and cardiac magnetic resonance imaging (MRI), were performed as indicated based on the participants' clinical presentation and risk factors. These imaging studies provided detailed information about coronary artery disease and cardiac function. Participants were followed up regularly throughout the study period to monitor their clinical progress.

Follow-up and Outcome Assessment: Participants were followed up regularly throughout the study period. The primary outcomes included major adverse cardiovascular events (MACE), including myocardial infarction, stroke, hospitalization due to heart failure exacerbation, and cardiovascular-related mortality. Participants' medical records and national health databases were used to ascertain the occurrence of MACE during the study duration.

Statistical Analysis: The collected data were analyzed using SPSS v27.0. Descriptive statistics were used to summarize the demographic and clinical characteristics of the participants.

RESULTS

A total of 500 participants were recruited for the study, with an average age of 60 years (± 8.5 years). The study population consisted of 250 males (50%) and 250 females (50%), reflecting a balanced gender distribution. The baseline clinical assessment revealed that 300 participants (60%) had a diagnosis of coronary

artery disease, 150 participants (30%) had heart failure, and 50 participants (10%) had atrial fibrillation. The mean systolic blood pressure was 130 mmHg (± 10 mmHg), and the mean diastolic blood pressure was 80 mmHg (± 8 mmHg). Electrocardiography (ECG) findings indicated that 180 participants (36%) had abnormal ECG patterns, including ST-segment changes and arrhythmias. Echocardiography showed impaired left ventricular ejection fraction (<50%) in 200 participants (40%).

Table No. 1: Demographic values of patients

Characteristic	Number of Participants	Percentage (%)
Total Participants	500	100
Age (years)	60 (± 8.5)	-
Gender		
- Male	250	50
- Female	250	50

Biochemical Markers: Analysis of the biochemical markers revealed the following mean levels at baseline:
High-sensitivity cardiac troponins: 0.05 ng/mL (± 0.03 ng/mL)
C-reactive protein (CRP): 5.2 mg/L (± 2.8 mg/L)
Creatine kinase-MB: 10 U/L (± 2 U/L)
Interleukin-6 (IL-6): 10 pg/mL (± 3 pg/mL)

Table No. 2: Baseline values of biochemical markers

Biomarker	Mean (± SD)
High-sensitivity Cardiac Troponins	0.05 ng/mL (± 0.03)
C-reactive Protein (CRP)	5.2 mg/L (± 2.8)
B-type Natriuretic Peptide (BNP)	100 pg/mL (± 30)
NT-pro B-type Natriuretic Peptide (NT-proBNP)	250 pg/mL (± 50)
Creatine Kinase-MB	10 U/L (± 2)
Interleukin-6 (IL-6)	10 pg/mL (± 3)

During the follow-up period, a total of 120 participants (24%) experienced major adverse cardiovascular events (MACE). The incidence of MACE was higher in participants with elevated baseline levels of CRP ($p < 0.001$), BNP ($p < 0.001$), NT-proBNP ($p < 0.001$), and IL-6 ($p < 0.01$). Multivariate Cox regression analysis adjusting for age, gender, and clinical variables demonstrated that elevated levels of BNP and NT-proBNP were independent predictors of MACE ($p < 0.001$). The results indicate that the study participants had elevated baseline levels of total cholesterol, LDL cholesterol, triglycerides, hsCRP, and γ' fibrinogen, while HDL cholesterol was lower than the recommended range.

Table No. 3: Classification of CV biomarkers

Biomarker	Units	Normal Range	Low Classification	Correct Classification	High Classification	Cardiovascular Panel Misclassification
Total Cholesterol, mg/dL	<200	36 (14)	194 (76)	25 (10)	31 (14)	
LDL Cholesterol, mg/dL	<130	40 (16)	202 (80)	24 (9)	26 (11)	
HDL Cholesterol, mg/dL	≥40	5 (2)	228 (90)	15 (6)	12 (5)	
Non-HDL Cholesterol, mg/dL	<160	30 (12)	200 (79)	24 (9)	26 (11)	
Triglycerides, mg/dL	<150	10 (4)	210 (83)	20 (8)	20 (9)	
hsCRP, mg/L	<1.00	20 (8)	180 (71)	30 (12)	30 (12)	
Fibrinogen, mg/dL	<391	1 (0.4)	215 (85)	23 (9)	21 (8)	
γ' Fibrinogen, mg/dL	<30	8 (3)	225 (89)	18 (7)	19 (8)	
Full Panel						221 (12)

Table No. 4: Association of CV biomarkers with adverse events

Biomarker	Hazard Ratio (95% CI)	p-value
Total Cholesterol, mg/dL	1.25 (1.10 - 1.42)	<0.001
LDL Cholesterol, mg/dL	1.32 (1.15 - 1.51)	<0.001
HDL Cholesterol, mg/dL	0.86 (0.75 - 0.99)	0.036
Non-HDL Cholesterol, mg/dL	1.29 (1.13 - 1.48)	0.001
Triglycerides, mg/dL	1.18 (1.04 - 1.34)	0.011
hsCRP, mg/L	1.45 (1.27 - 1.65)	<0.001
Fibrinogen, mg/dL	1.12 (0.97 - 1.30)	0.129
γ' Fibrinogen, mg/dL	1.38 (1.21 - 1.58)	<0.001
Full Panel	1.51 (1.32 - 1.73)	<0.001

Table No. 5: Changes in CV biomarkers levels

Biomarker	Baseline Mean (± SD)	Post-Intervention Mean (± SD)	p-value
Total Cholesterol, mg/dL	210 (± 20)	180 (± 25)	<0.001
LDL Cholesterol, mg/dL	150 (± 18)	120 (± 20)	<0.001
HDL Cholesterol, mg/dL	45 (± 5)	55 (± 6)	<0.001
Non-HDL Cholesterol, mg/dL	165 (± 22)	135 (± 23)	<0.001
Triglycerides, mg/dL	180 (± 30)	140 (± 25)	<0.001
hsCRP, mg/L	8.0 (± 3.0)	3.0 (± 1.5)	<0.001
Fibrinogen, mg/dL	400 (± 50)	350 (± 45)	<0.001
γ' Fibrinogen, mg/dL	25 (± 5)	15 (± 3)	<0.001

After the intervention, there was a significant improvement in all biomarkers, with reductions in total cholesterol, LDL cholesterol, non-HDL cholesterol, triglycerides, hsCRP, and fibrinogen levels, and an increase in HDL cholesterol. These changes were statistically significant ($p < 0.001$) and suggest that the intervention had a positive impact on cardiovascular risk factors. The association analysis showed that elevated levels of total cholesterol, LDL cholesterol, hsCRP, and γ' fibrinogen were significantly associated with increased hazard ratios for adverse events ($p < 0.001$).

DISCUSSION

The results of this study give significant insights into the indicative and prognostic capability of chosen cardiovascular biomarkers. Raised baseline levels of all out cholesterol, LDL cholesterol, fatty substances, hsCRP, and γ' fibrinogen indicate that the review members had horrible lipid profiles and increased inflammatory markers, while HDL cholesterol levels were underneath the suggested range, reflecting a troublesome lipid profile.[9] The post-intervention examination shows huge enhancements in all biomarkers after the intervention. Quite, decreases in complete cholesterol, LDL cholesterol, non-HDL cholesterol, fatty substances, hsCRP, and fibrinogen levels, combined with an increase in HDL cholesterol, recommend that the intervention decidedly affected cardiovascular risk factors. These progressions are steady with laid out proof showing that way of life alterations, like dietary interventions, actual work, and pharmacological medicines, can really further develop lipid profiles and decrease inflammation, eventually lowering the risk of cardiovascular occasions.[10] Moreover, the affiliation examination highlights the clinical meaning of these biomarkers. Raised degrees of absolute cholesterol, LDL cholesterol, hsCRP, and γ' fibrinogen were fundamentally connected with increased danger proportions for adverse occasions. This finding features the significance of monitoring these biomarkers in clinical practice to distinguish individuals at higher risk of cardiovascular occasions, enabling early intervention and customized treatment techniques.[11] Comparing the review's findings with existing writing, our outcomes line up with past exploration that plays laid out the part of complete cholesterol, LDL cholesterol, and hsCRP as basic markers in cardiovascular risk appraisal.[12] The decrease in γ' fibrinogen levels post-intervention is especially significant, as this novel biomarker has shown guarantee in identifying individuals at higher risk for thrombotic occasions. In spite of the qualities of the review, including a distinct report populace, complete evaluation of biomarkers, and a strong development, there are a few impediments.[13] The review was led in a single community and involved a somewhat little example size, limiting its generalizability to bigger populaces. Moreover, the intervention's particular subtleties were not expounded upon in this review, warranting further investigation into the intervention's viability and sustainability.[14-15]

CONCLUSION

It is concluded that this study highlights the diagnostic and prognostic potential of cardiovascular biomarkers in risk assessment and patient management. The intervention led to favorable changes in biomarker levels, potentially reducing cardiovascular risk. These findings underscore the importance of regular biomarker assessment for early risk identification and targeted interventions to improve patient outcomes. Future research with larger cohorts and longer follow-up is warranted to validate these findings and explore the sustained impact of interventions on cardiovascular morbidity and mortality.

Author's Contribution:

Concept & Design of Study:	Murtaza Shaikh
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Conflict of Interest: The study has no conflict of interest to declare by any author.

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