The Research Journal of Medical Sciences
[E-ISSN: 3078-2481| P-ISSN: 3078-2473]
Available on: https://rjmsonline.com/
Volume: 03 | Issue: 01, 2021
DOI: 10.5281/zenodo.23435337



Research Article *Open Access*

Evaluation of High-Sensitivity C-Reactive Protein as a Biomarker of Cardiovascular Risk

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Source of support: Nil.
Conflict of interest: None

Received: 06-02-2021
Accepted: 15-03-2021
Available online: 26-03-2021

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Published by TRJMS

Abstract

Background: Cardiovascular diseases remain a major cause of illness and death worldwide. In addition to traditional risk factors such as hypertension, diabetes mellitus, smoking, and dyslipidaemia, inflammation plays an important role in the development and progression of atherosclerosis. High-sensitivity C-reactive protein (hs-CRP) is a sensitive laboratory marker of systemic inflammation that may provide additional information about cardiovascular risk.
Aim: To evaluate high-sensitivity C-reactive protein as a biomarker of cardiovascular risk among patients attending a healthcare facility.
Materials and Methods: This study included 85 patients evaluated at B.P. Koirala Institute between January 2018 and January 2020. The study design, eligibility criteria, demographic characteristics, clinical variables, and laboratory methods should be reported according to the original study records. Relevant variables may include age, sex, blood pressure, smoking status, diabetes mellitus, lipid profile, and serum hs-CRP concentration. The association between hs-CRP and established cardiovascular risk factors should be assessed using appropriate statistical methods.
Results: The study-specific findings, including the mean or median hs-CRP concentration, distribution of cardiovascular risk factors, and statistical associations, must be entered after analysis of the original patient records. These results cannot be established from the sample size and study period alone.
Conclusion: hs-CRP may provide additional information about inflammation-associated cardiovascular risk when interpreted alongside established clinical and biochemical risk factors. Its value in the present study must be determined from the actual patient data.

Keywords: *High-sensitivity C-reactive protein; cardiovascular risk; inflammation; atherosclerosis; lipid profile; clinical biochemistry.*

INTRODUCTION

Cardiovascular diseases represent a major public health challenge and are influenced by several interacting risk factors. Hypertension, diabetes mellitus, smoking, dyslipidaemia, obesity, physical inactivity, and family history are among the established factors associated with cardiovascular disease. Although these factors remain central to risk assessment, research has also highlighted the role of inflammation in the development and progression of atherosclerosis.

Atherosclerosis is not simply the accumulation of lipids within arterial walls. It is a complex process involving inflammatory cells, endothelial dysfunction, lipid deposition, and changes in the structure of blood vessels. Inflammatory activity may contribute to plaque development and instability, potentially increasing the risk of cardiovascular events [1].

C-reactive protein (CRP) is an acute-phase protein produced predominantly by the liver in response to inflammatory signals. High-sensitivity CRP assays can measure low concentrations of this protein more accurately than conventional CRP assays. This makes hs-CRP potentially useful for assessing low-grade systemic inflammation in selected individuals without an obvious acute inflammatory condition [1,2].

The clinical relevance of hs-CRP lies in its potential to complement conventional cardiovascular risk assessment. However, an elevated result is not specific to cardiovascular disease. Infection, inflammatory disorders, tissue injury, and other conditions can also increase its concentration. Therefore, hs-CRP should not be interpreted in isolation.

The present study was planned to evaluate hs-CRP as a biomarker of cardiovascular risk among 85 patients studied at B.P. Koirala Institute during January 2018 to January 2020.

AIM AND OBJECTIVES

Aim

To evaluate high-sensitivity C-reactive protein as a biomarker of cardiovascular risk among patients attending B.P. Koirala Institute

Objectives

1. To measure serum hs-CRP concentrations in the study population.
2. To describe the demographic and clinical characteristics of the participants.
3. To assess the relationship between hs-CRP concentrations and available cardiovascular risk factors.
4. To examine the association between hs-CRP and biochemical parameters, particularly the lipid profile, where these data are available.
5. To explore whether hs-CRP provides additional information alongside conventional cardiovascular risk factors.

MATERIALS AND METHODS

Study design

The study design should be specified from the original protocol. If the investigators collected clinical and laboratory information at a single assessment, a cross-sectional analytical design may be appropriate. If participants were followed over time, the design and follow-up period should instead be reported accordingly.

Study setting and duration

The study was conducted at B.P. Koirala Institute from January 2018 to January 2020 in the Department of Biochemistry, in collaboration with the relevant clinical department where applicable.

Study population and sample size

A total of 85 patients were included. The original records should clarify whether participants were recruited consecutively, selected retrospectively from medical records, or enrolled using another sampling method.
The age range, sex distribution, clinical presentation, and cardiovascular risk profile should be reported from the source data.

Inclusion and exclusion criteria

The eligibility criteria should reflect those actually applied during the study. For a study assessing hs-CRP in cardiovascular risk evaluation, relevant considerations may include:

Potential inclusion criteria

- Patients meeting the study's prespecified age and clinical eligibility criteria.
- Patients with documented hs-CRP measurements and the clinical information required for analysis.
- Participants for whom consent or an approved waiver was obtained, as applicable to the study design.

Potential exclusion criteria

- Acute infection or an active inflammatory condition at the time of testing, if these were excluded by the original protocol.
- Recent trauma, surgery, or other conditions likely to substantially influence hs-CRP, if specified in the protocol.
- Missing essential clinical or laboratory information, according to prespecified criteria.

These are suggested considerations, not confirmation of the criteria used in the original study. The final manuscript must report the actual criteria.

Clinical and biochemical assessment

Clinical information may include age, sex, blood pressure, smoking history, diabetes status, hypertension, family history of cardiovascular disease, and relevant medication use. Laboratory information may include hs-CRP and lipid parameters such as total cholesterol, triglycerides, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol.
Only variables actually recorded should be included in the final analysis.

Estimation of hs-CRP

Serum hs-CRP should be measured using the method documented in the original laboratory records. Depending on the laboratory platform, this may involve a validated high-sensitivity immunoturbidimetric or immunoassay method.
Results should be reported in mg/L. The instrument, assay manufacturer, calibration procedure, and quality-control measures should be stated when these details are available. Laboratory methodology and quality assurance are important because assay performance can influence the interpretation of low hs-CRP concentrations [2].

Interpretation of hs-CRP

For cardiovascular risk assessment in appropriately selected adults, hs-CRP values are often described using the following conventional categories:

hs-CRP concentration	Conventional interpretation
Less than 1 mg/L	Lower relative cardiovascular risk
1–3 mg/L	Intermediate relative cardiovascular risk
Greater than 3 mg/L	Higher relative cardiovascular risk

These categories are intended for cardiovascular risk interpretation in a suitable clinical context, not for diagnosing cardiovascular disease. Results may be misleading when acute infection or another inflammatory condition is present. A value above 10 mg/L generally warrants consideration of an active inflammatory process and reassessment when clinically appropriate [1,2].

Statistical analysis

Data should be analysed using appropriate statistical software. Continuous variables may be summarised as mean and standard deviation when approximately normally distributed, or median and interquartile range when distributions are skewed. Categorical variables should be presented as frequencies and percentages.

Associations between hs-CRP and cardiovascular risk factors may be examined using Pearson or Spearman correlation, depending on the data distribution and assumptions. Comparisons between groups may use suitable parametric or non-parametric tests. Multivariable regression may be considered if the available sample size, number of outcomes, and completeness of the data support it.

The significance threshold and statistical tests actually used should be stated. Effect estimates and confidence intervals should be reported where possible, rather than relying only on p-values.

Ethical considerations

The manuscript should state the name of the approving ethics committee, approval number, and consent arrangements as documented in the original study. For retrospective data, the relevant committee's decision concerning consent or a waiver should be reported accurately. Approval details must not be invented.

RESULTS

A total of 84 patient records were available for analysis. The recorded ages ranged from 19 to 92 years, with a mean age of 53.88 ± 14.79 years and a median age of 54 years. The largest age group was 40–59 years, comprising 40 patients (47.6%).

The mean recorded GCS score was 10.65 ± 4.07. A GCS score of 13–15 was observed in 34 patients (40.5%), while 24 patients (28.6%) had scores between 3 and 8. The recorded haematoma volume ranged from 5 to 40 units, with a mean of 16.95 ± 8.36 and a median of 15. The unit for haematoma volume should be confirmed from the original records.

Table 1. Demographic and clinical characteristics of the study population (N = 84)

Characteristic	Number (%) or mean ± SD
Age (years)	
Mean ± SD	53.88 ± 14.79
Median (range)	54 (19–92)
Age ≤39 years	15 (17.9%)
Age 40–59 years	40 (47.6%)
Age 60–79 years	26 (31.0%)
Age ≥80 years	3 (3.6%)
Initial GCS score	
Mean ± SD	10.65 ± 4.07
GCS 3–8	24 (28.6%)
GCS 9–12	26 (31.0%)
GCS 13–15	34 (40.5%)
Haematoma volume	
Mean ± SD	16.95 ± 8.36
Median (range)	15 (5–40)
Volume ≤10	26 (31.0%)
Volume 11–20	37 (44.0%)
Volume 21–30	17 (20.2%)
Volume >30	4 (4.8%)
Intraventricular haemorrhage (IVH)	

Present	38 (45.2%)
Absent	46 (54.8%)
Infratentorial involvement	
Present	39 (46.4%)
Absent	45 (53.6%)

Values are presented as mean ± standard deviation, median (range), or number (percentage), as appropriate. Haematoma-volume units and the coding of infratentorial involvement should be verified against the source records.

The ICH score ranged from 0 to 5. An ICH score of 1 was the most frequently recorded score, occurring in 22 patients (26.2%), followed by a score of 0 in 19 patients (22.6%). Scores of 4 and 5 were recorded in 10 (11.9%) and 4 (4.8%) patients, respectively.

Table 2. Distribution of ICH scores and follow-up functional outcomes

Variable	Category	Number (%)
ICH score	0	19 (22.6%)
	1	22 (26.2%)
	2	13 (15.5%)
	3	16 (19.0%)
	4	10 (11.9%)
	5	4 (4.8%)
Follow-up mRS	0	12 (14.3%)
	1	13 (15.5%)
	2	15 (17.9%)
	3	13 (15.5%)
	4	13 (15.5%)
	5	9 (10.7%)
	6	9 (10.7%)
NIHSS	Mean ± SD	10.54 ± 5.46
	Median (range)	10.5 (1–27)

The follow-up mRS scores ranged from 0 to 6, with a median of 3. A score of 2 was the most frequently recorded outcome, observed in 15 patients (17.9%). Nine patients (10.7%) had an mRS score of 6. The timing of follow-up was not specified in the supplied dataset and should be reported from the study protocol.

Figure 1. Distribution of patients according to initial GCS score



Interpretation: In this dataset, 50 patients (59.5%) had an initial GCS score of 12 or below. IVH was recorded in 38 patients (45.2%), and infratentorial involvement was recorded in 39 (46.4%). These are descriptive findings only; no association between ICH score, haematoma volume, GCS, NIHSS, and follow-up mRS has been tested here.

DISCUSSION

High-sensitivity C-reactive protein has attracted interest as a biomarker because it reflects systemic inflammation, a process involved in atherosclerosis. Unlike a conventional cardiovascular risk factor such as blood pressure or cholesterol, hs-CRP does not directly measure a specific vascular abnormality. Instead, it provides information about an inflammatory component that may complement the assessment of cardiovascular risk [1].

The interpretation of the present study will depend on the distribution of hs-CRP concentrations and the clinical characteristics of the 85 participants. If higher hs-CRP concentrations are observed among patients with established cardiovascular risk factors, the finding may support an association between inflammation and an adverse risk profile. However, such an association would not establish that hs-CRP independently predicts future cardiovascular events.

Previous research has examined hs-CRP as a marker for cardiovascular risk stratification and residual inflammatory risk. Arroyo-Espliguero and colleagues discussed the potential value of CRP in primary and secondary prevention while highlighting the need to interpret the biomarker in the context of established risk factors and current clinical guidance [1].

It is also important to recognise that hs-CRP is a non-specific marker. Infection, inflammatory disease, trauma, and other conditions can raise concentrations independently of atherosclerotic risk. Consequently, clinical context and, when appropriate, repeat measurement are important when results are unexpected or substantially elevated [2].

A further consideration is whether hs-CRP provides meaningful additional information beyond conventional risk assessment. A statistically significant correlation with cholesterol, blood pressure, or diabetes would not, by itself, demonstrate improved cardiovascular prediction. Demonstrating incremental predictive value generally requires appropriate outcome data and analyses comparing risk models with and without the biomarker.

The findings should therefore be discussed in relation to the study's actual measurements, participant selection, assay method, and statistical results. If the study did not follow patients for subsequent cardiovascular events, conclusions should be restricted to the observed associations rather than describing hs-CRP as a proven predictor of future events.

Limitations

The final limitations should reflect the actual study design and data. Potential limitations include the relatively small sample size, single-centre setting, incomplete information on confounding factors, and the non-specific nature of hs-CRP. If the study was cross-sectional, it would not establish temporal relationships or demonstrate that hs-CRP predicts future cardiovascular events. If the study relied on retrospective records, missing data and differences in clinical documentation may also have affected the analysis. These limitations should be retained only where applicable to the original study.

CONCLUSION

High-sensitivity C-reactive protein is a clinically relevant marker of systemic inflammation and may provide additional information during cardiovascular risk assessment in selected patients. However, it should be interpreted alongside established clinical and biochemical risk factors and not used as a stand-alone diagnostic test for cardiovascular disease.

The present study of 85 patients can help describe the relationship between hs-CRP and cardiovascular risk factors recorded during January 2018 to January 2020. The strength and clinical relevance of any observed associations must be established through analysis of the original patient data. Further studies with larger populations and prospective cardiovascular outcome assessment may help clarify the incremental predictive value of hs-CRP.

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