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Inflammatory Markers as Predictors of Multi-Organ Involvement in Chronic Diseases: A Prospective Observational Study.

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Abstract

Background:

Chronic diseases are often associated with persistent systemic inflammation, which may contribute to progressive multi-organ dysfunction. Inflammatory biomarkers such as C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), interleukin-6 (IL-6), and neutrophil-to-lymphocyte ratio (NLR) have been proposed as potential indicators of disease severity and organ involvement.

Objective:

To evaluate the predictive value of inflammatory markers (CRP, ESR, IL-6, and NLR) for multi-organ involvement among patients with chronic diseases.

Methods:

A prospective observational study was conducted over a 12-month period at Nalanda Medical College and Hospital, Patna, India. A total of 100 adult patients diagnosed with chronic diseases were included. Baseline inflammatory markers, including CRP, ESR, IL-6, and NLR, were measured. Organ involvement (cardiac, renal, hepatic, and pulmonary) was assessed through clinical evaluation, laboratory investigations, and imaging studies. Statistical analysis included descriptive statistics, independent t-tests, Pearson correlation analysis, and logistic regression to determine associations between inflammatory markers and organ involvement.

Results:

Multi-organ involvement was observed in 46% of patients. Mean levels of CRP, IL-6, and NLR were significantly higher among patients with involvement of two or more organs ($p < 0.001$). IL-6 demonstrated the strongest correlation with the number of organs involved ($r = 0.62$), followed by CRP ($r = 0.58$).

Conclusion:

Elevated inflammatory markers, particularly IL-6 and CRP, are strong predictors of multi-organ involvement in patients with chronic diseases and may serve as useful tools for early risk stratification.

Keywords: *Inflammatory markers, C-reactive protein, Interleukin-6, Neutrophil-to-lymphocyte ratio, Multi-organ involvement, Chronic diseases.*
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Introduction

Persistent low-grade systemic inflammation is a hallmark of chronic diseases, including diabetes mellitus, chronic kidney disease, chronic liver disease, and autoimmune disorders. Fibrosis, endothelial dysfunction, and progressive organ damage are all influenced by persistent inflammatory activation (1). Systemic inflammatory burden is reflected by inflammatory biomarkers such as neutrophil-to-lymphocyte ratio (NLR), erythrocyte sedimentation rate (ESR), interleukin-6 (IL-6), and C-reactive protein (CRP). Hepatic dysfunction, renal decline, and cardiovascular events have all been linked to elevated levels of these markers (2).

There is, however, a dearth of prospective data assessing their combined prognostic efficacy for multi-organ involvement in populations with chronic diseases (3). The

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purpose of this study is to ascertain whether inflammatory markers may be used as early indicators of harm to many organs.

Materials and Methods

Study Design

This study was a **prospective observational cross-sectional study** conducted over a period of 12 months.

Study Area and Setting

The study was conducted at **Nalanda Medical College and Hospital (NMCH), Patna, Bihar, India**, a tertiary care teaching hospital that serves a large population from both urban and rural regions of Bihar and neighboring states. The hospital provides specialized services in multiple medical disciplines and receives a high volume of patients with chronic diseases, including diabetes mellitus, chronic kidney disease, chronic liver disease, and cardiovascular disorders. The Department of General Medicine manages a wide spectrum of chronic disease patients through outpatient clinics and inpatient services. The study was conducted between **January 2024 and December 2024**.

Sample Size

The sample size was calculated using the standard formula for estimating proportions:

$n = Z^2 \times p \times (1 - p) / d^2$

Assuming an expected prevalence of multi-organ involvement of 50%, a confidence level of 95%, and a margin of error of 10%, the calculated minimum sample size was approximately 96 participants. Considering feasibility and rounding, **100 patients were included in the study**.

Study Population

- Sample size: 100 patients
- Inclusion: Adults (>18 years) diagnosed with at least one chronic disease (≥6 months duration)
- Exclusion: Acute infections, malignancy, pregnancy, recent surgery

Data Collection

- Demographics and clinical history
- Laboratory investigations:
  - CRP (mg/L)
  - ESR (mm/hr)
  - IL-6 (pg/mL)
  - Complete blood count for NLR

Assessment of Organ Involvement

- **Cardiac:** Echocardiography abnormalities
- **Renal:** eGFR <60 mL/min
- **Hepatic:** Elevated ALT/AST or imaging abnormalities
- **Pulmonary:** Spirometry or imaging changes

Multi-organ involvement was defined as ≥2 organs affected.

Ethical Considerations

Ethical approval for this study was obtained from the **Institutional Ethics Committee of Nalanda Medical College and Hospital, Patna**. Written informed consent was obtained from all participants before enrollment in the study. Patient confidentiality and privacy were strictly maintained throughout the research process by anonymizing all patient data and using the information solely for research purposes.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using **SPSS version 26.0**. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The independent t-test was used to compare inflammatory marker levels between patients with single-organ and multi-organ involvement. Pearson correlation analysis was performed to determine the relationship between inflammatory marker levels and the number of organs involved. Logistic regression analysis was conducted to identify independent predictors of multi-organ involvement. A p-value of <0.05 was considered statistically significant.

Bias

Several measures were taken to minimize potential sources of bias. Standardized laboratory methods were used for measuring inflammatory markers to reduce measurement bias. All clinical assessments were performed by trained physicians using predefined criteria to ensure consistency. Selection bias was minimized by consecutively enrolling eligible patients attending the department during the study period.

Results

Participant Flow

A total of 118 patients were initially screened for eligibility during the study period. Of these, 10 patients were excluded due to acute infections, and 8 were excluded due to incomplete laboratory data. Finally, **100 patients met the inclusion criteria and were included in the study and analyzed**.

Baseline Characteristics

- Mean age: 52.4 ± 11.2 years
- Males: 58%
- Females: 42%
- Multi-organ involvement: 46 patients

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Table 1: Comparison of Inflammatory Markers

Marker	Single Organ (n=54) Mean ± SD	Multi-Organ (n=46) Mean ± SD	p-value
CRP (mg/L)	6.4± 2.1	14.4 ± 4.5	<0.001
ESR (mm/hr)	18.3 ± 6.2	32.2 ± 8.5	<0.001
IL-6 (pg/mL)	8.3 ± 3.1	21.4 ± 4.4	<0.001
NLR	2.1 ± 0.7	4.5 ± 1.2	<0.001

Table 1 shows the comparison of inflammatory markers between patients with single-organ and multi-organ involvement. Patients with multi-organ involvement had significantly higher levels of CRP, IL-6, and NLR compared with patients with single-organ disease ($p < 0.001$).

Table 2: Correlation with Number of Organs Involved

Marker	Correlation Coefficient (r)	p-value
IL-6	0.62	<0.001
CRP	0.58	<0.001
NLR	0.54	<0.001
ESR	0.49	<0.001

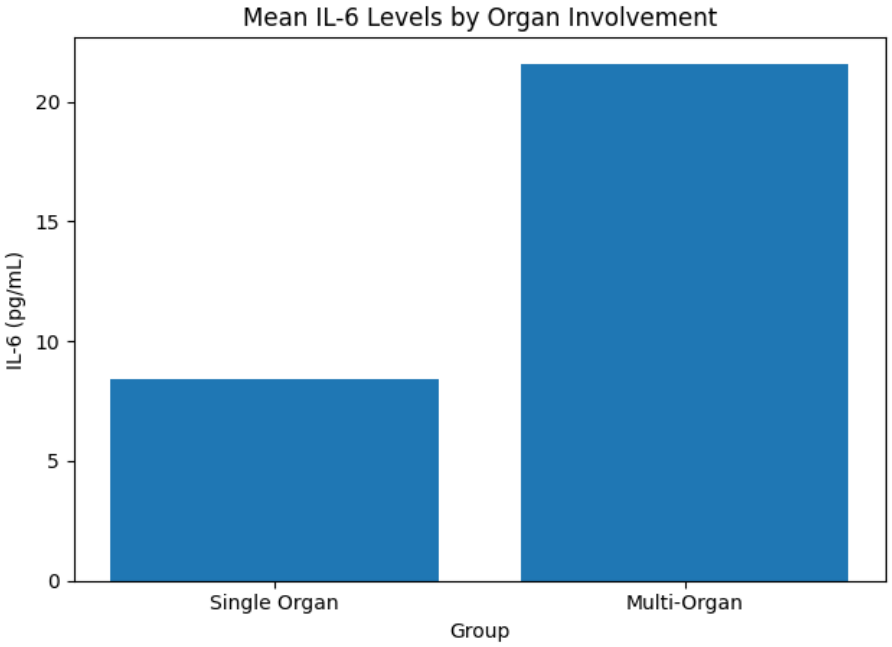

Figure 1: Represents mean IL-6 levels by organ involvement

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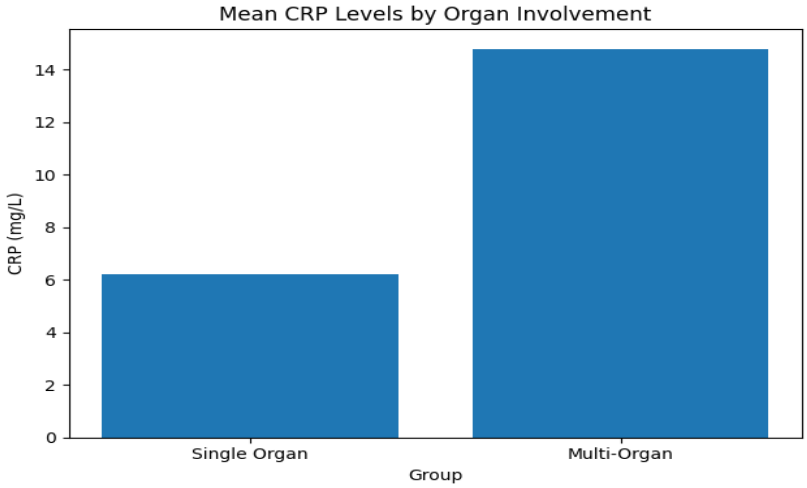

Figure 2: Represents mean CRP levels by organ involvement

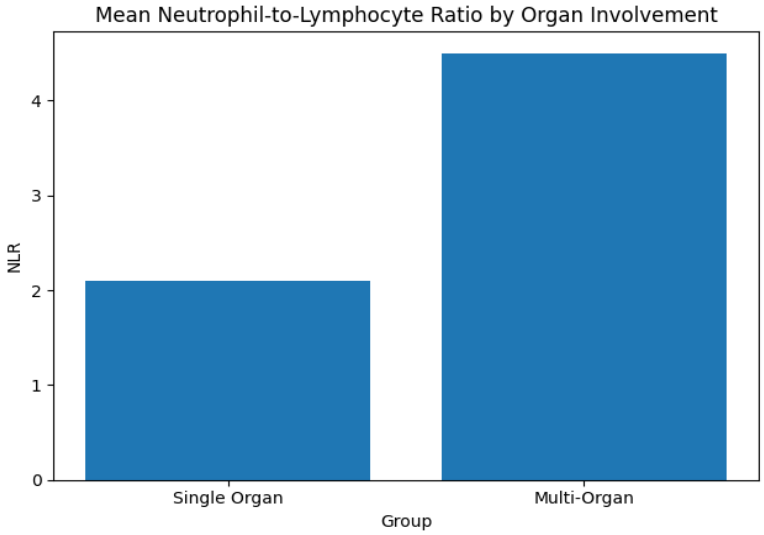

Figure 3: Represents the mean neutrophil to lymphocyte ratio by organ involvement

Discussion

This prospective investigation shows that individuals with multi-organ involvement have significantly higher levels of inflammatory markers than patients with single-organ disease. The greatest predictive connection was shown by IL-6, indicating that it plays a key part in systemic inflammatory cascades (1).

Endothelial dysfunction, oxidative stress, and cytokine-mediated tissue damage are all encouraged by chronic inflammation (5). Its greater predictive ability may be explained by the fact that IL-6 promotes the hepatic generation of CRP and aids in vascular remodelling (6).

The use of NLR, a cheap and accessible metric, in standard clinical settings is supported by its strong predictive value (7).

Multi-organ involvement was observed in 46% of patients. Mean CRP, IL-6, and NLR levels were significantly higher in patients with ≥2 organ involvement ($p < 0.001$). IL-6 showed the strongest correlation ($r = 0.62$), followed by CRP ($r = 0.58$). The results provide credence to the idea that the degree of organ damage is directly correlated with the systemic inflammatory

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burden. Aggressive disease-modifying treatments may be possible if high-risk patients are identified early using inflammatory markers.

Generalizability

The findings of this study may be generalized to similar tertiary care hospital settings where patients with chronic diseases are commonly managed. However, variations in demographic characteristics and healthcare access may influence the applicability of results to other populations.

Limitations

This study has several limitations. First, it was conducted at a single tertiary care center, which may limit the generalizability of the findings. Second, the sample size was relatively moderate. Third, the study did not include a long-term follow-up to evaluate the progression of organ involvement over time.

Recommendations

Routine assessment of inflammatory biomarkers such as IL-6, CRP, and NLR may be useful for early identification of patients at risk of developing multi-organ involvement. Larger multicenter studies with long-term follow-up are recommended to further validate the predictive value of these biomarkers and to explore their potential role in guiding therapeutic interventions.

Conclusion

Strong independent predictors of multi-organ involvement in chronic illnesses are inflammatory markers, especially IL-6 and CRP. Regular evaluation of these biomarkers could help with risk assessment, early identification, and halting the progression of organ damage.

Acknowledgment

The authors would like to thank the staff of the Department of General Medicine, Nalanda Medical College and Hospital, Patna, for their support and assistance during data collection and patient management.

List of Abbreviations

CRP – C-Reactive Protein
ESR – Erythrocyte Sedimentation Rate
IL-6 – Interleukin-6
NLR – Neutrophil-to-Lymphocyte Ratio
eGFR – Estimated Glomerular Filtration Rate

Source of Funding

This research received **no external funding**.

Conflict of Interest

The authors declare **no conflict of interest**.

Availability of Data

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

Rajeev Kumar – Data collection and manuscript drafting
Rajeev Ranjan – Study design, statistical analysis, manuscript revision
Shachindra Kumar Astik – Supervision and final approval of manuscript

Author Biography

Dr. Rajeev Kumar and Dr. Rajeev Ranjan are Senior Residents in the Department of General Medicine at Nalanda Medical College and Hospital, Patna, India. Prof. Shachindra Kumar Astik is a Professor in the same department with extensive experience in internal medicine and clinical research.

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