

The Relationship Between CRP Levels and Hospitalization, Discharge, Readmission and Mortality Rates of Geriatric Patients Presenting to the Emergency Department

Acil Servise Başvuran Geriatrik Hastaların CRP Düzeyi ile Hastaneye Yatış, Taburculuk, Yeniden Başvuru, Mortalite Oranları Arasındaki İlişki

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ABSTRACT

Aim: This study aims to investigate the association between C-reactive protein (CRP) levels and outcomes such as hospitalization, discharge, readmission, and mortality in geriatric patients (aged 65 and over) presenting to the emergency department for non-traumatic reasons.

Material and Methods: CRP levels were retrospectively analyzed from blood tests taken during routine diagnostic and therapeutic processes for patients over 65 years of age who presented to the emergency department of a secondary state hospital for non-traumatic reasons between January 1, 2023, and June 30, 2023. Patients were categorized into five CRP level groups (5-50 mg/L, 51-100 mg/L, etc.) and evaluated for their medical history, complaints, hospitalization status, consultation requests, and mortality.

Results: Patients with CRP levels between 5-100 mg/L were more frequently diagnosed with non-infective causes, while CRP levels over 101 mg/L were predominantly associated with infective causes. A statistically significant association was found between elevated CRP levels and increased rates of hospitalization and mortality ($p < 0.001$).

Conclusion: A significant relationship was observed between CRP levels and the rates of consultation and hospitalization in geriatric patients admitted to the emergency department for non-traumatic reasons. Additionally, elevated CRP levels were strongly associated with increased mortality rates among hospitalized patients. The findings indicate that CRP levels exceeding 101 mg/L were associated with infectious diagnoses and poor outcomes, highlighting the need for close monitoring of these patients. CRP levels should be considered an integral part of the decision-making process in geriatric emergency patients.

Keywords: Geriatric patient, CRP levels, mortality, emergency department

ÖZ

Amaç: Bu çalışma, travmatik olmayan sebeplerle acil servise başvuran 65 yaş ve üzeri geriatrik hastalarda C-reaktif protein (CRP) düzeyleri ile hastaneye yatış, taburculuk, yeniden başvuru ve mortalite gibi sonuçlar arasındaki ilişkiyi araştırmayı amaçlamaktadır.

Gereç ve Yöntemler: 1 Ocak 2023 ile 30 Haziran 2023 tarihleri arasında, travmatik olmayan sebeplerle bir ikinci basamak devlet hastanesi acil servisine başvuran 65 yaş üstü hastalardan rutin tanı ve tedavi süreçleri sırasında alınan kan testlerinden elde edilen CRP düzeyleri retrospektif olarak analiz edilmiştir. Hastalar beş farklı CRP düzey grubuna (5-50 mg/L, 51-100 mg/L vb.) ayrılmış ve tıbbi geçmipleri, şikayetleri, hastaneye yatış durumları, konsültasyon talepleri ve mortalite sonuçları değerlendirilmiştir.

Bulgular: CRP düzeyleri 5-100 mg/L arasında olan hastalar daha sık enfektif olmayan nedenlerle tanı alırken, CRP düzeyleri 101 mg/L ve üzerinde olan hastaların çoğunlukla enfektif nedenlerle tanı aldığı gözlemlenmiştir. Yükselmiş CRP düzeyleri ile artmış hastaneye yatış ve mortalite oranları arasında istatistiksel olarak anlamlı bir ilişki bulunmuştur ($p < 0,001$).

Sonuç: Travmatik olmayan sebeplerle acil servise başvuran geriatrik hastalarda CRP düzeyleri ile konsültasyon ve hastaneye yatış oranları arasında anlamlı bir ilişki gözlemlenmiştir. Ayrıca, yüksek CRP düzeylerinin hastaneye yatırılan hastalar arasında artan mortalite oranları ile güçlü bir şekilde ilişkili olduğu tespit edilmiştir. Bulgular, CRP düzeylerinin 101 mg/L'yi aşması durumunda enfektif tanılar ve olumsuz sonuçlarla ilişkili olduğunu göstermekte ve bu hastaların yakından izlenmesi gerektiğini vurgulamaktadır. CRP düzeyleri, geriatrik hastaların acil servislerdeki karar verme süreçlerinde önemli bir faktör olarak değerlendirilmelidir.

Anahtar Kelimeler: Geriatrik hasta, CRP düzeyleri, mortalite, acil servis

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Introduction

C-reactive protein (CRP) is produced in response to inflammation, with elevated levels indicating systemic involvement. As an acute-phase protein, CRP levels can rise rapidly after tissue damage or infection and gradually decline as the inflammatory process resolves (1). CRP is initially produced at sites of inflammation and infection in a monomeric form, referred to as monomeric CRP (mCRP). It is synthesized in many cells such as hepatocytes, smooth muscle cells, endothelium and macrophages. Although CRP is considered to be an indicator of infection and cardiac events, there is increasing evidence that it provides significant support to the host in inflammatory processes such as complement pathway, phagocytosis, apoptosis and release of cytokines (2).

CRP levels can rise significantly during inflammatory processes, including rheumatologic diseases, cardiovascular events, and infections (3). As an acute-phase protein, CRP levels increase rapidly in response to inflammation, with changes of at least 25% observed during such events. However, when the stimuli cease, CRP values gradually decrease over 8-18 hours, reflecting its half-life. In seemingly healthy individuals, several factors such as age, weight, gender, and smoking status can also influence CRP levels (4). As a non-specific marker of systemic inflammation, CRP is associated with higher mortality and worse clinical outcomes in elderly patients, particularly in vascular events like intracranial hemorrhage, ischemic stroke, and coronary disorders (5). As the inflammatory response evolves with aging, it is further complicated by the presence of multiple comorbidities and disabilities. This makes it challenging to assess the clinical significance of serum CRP levels in older adults with acute infections, especially considering age-related changes in immunity and cytokine production (6).

While CRP is a well-established marker of inflammation, its utility in predicting clinical outcomes such as hospitalization rates and mortality in geriatric patients presenting with non-traumatic conditions is under-explored. This study aims to address this gap by investigating the correlation between CRP levels and patient outcomes in this population. Previous studies have demonstrated the predictive value of CRP in infectious and non-infectious conditions in younger populations. However, its association with outcomes such as hospitalization and discharge decisions in geriatric patients, particularly in emergency settings, warrants further investigation. We hypothesize that elevated CRP levels in geriatric patients are significantly associated with increased hospitalization rates, readmission within seven days, and higher mortality.

Material and Methods

In this study, CRP levels from routine blood tests taken during the diagnosis and treatment of patients over 65 years old who presented to the emergency department (ED) of a secondary state hospital for non-traumatic reasons between January 1, 2023, and June 30, 2023, were retrospectively analyzed. CRP levels of the patients were compared with discharge, readmission, hospitalization and mortality as variables.

Using discharge summaries and ICD-10 codes obtained from the HIS system, patients were categorized into two main

categories: infectious and non-infectious causes. Data were collected by recording the information accessed through the hospital HIS system on pre-prepared forms. Patients under 65 years of age or those presenting with traumatic injuries were excluded from the study. Additionally, patients with missing data or incomplete records in the hospital HIS system were also excluded.

CRP levels were categorized based on clinically relevant thresholds used in previous studies and were classified into five groups: 5-50, 51-100, 101-150, 151-200, and >200 mg/L. These categories were selected to capture significant variations in CRP levels commonly associated with different clinical outcomes in geriatric patients.

Ethical approval for the study was obtained from the Karadeniz Technical University Faculty of Medicine Ethics Committee (Approval Date: November 8, 2023; No: 2023/200). Due to the retrospective nature of the study, patient consent was waived. All patient data were anonymized to ensure confidentiality.

The sample size was determined using G Power analysis, with an effect size of 0.3, a significance level of 0.05, and a power of 80%. The analysis indicated that a minimum of 133 patients were required to achieve sufficient statistical power for the study. In the statistical analysis, the data were uploaded to SPSS 23.0 (Chicago, USA) and analyzed.

The conformity of the data to normal distribution was evaluated by histogram, Q-Q graphs and Shapiro-Wilk test. For normally distributed variables, mean and standard deviation were used as descriptive statistics. For non-normally distributed variables, median (1st quartile-3rd quartile) values were reported. In qualitative variables, numbers and percentages were used as descriptive statistics. The Pearson χ^2 test and Fisher's exact test were used to compare qualitative variables due to the categorical nature of the data. These tests were selected to determine statistically significant associations between CRP levels and clinical outcomes, such as hospitalization and mortality. Significance level was accepted as $p < 0.05$.

Results

Patients over 65 years of age admitted to the emergency department for non-traumatic reasons within a 6-month period were retrospectively screened. A total of 647 patients were initially screened for the study. However, 142 patients were excluded due to being trauma patients or having missing data in hospital records. Ultimately, 505 patients were included in the final analysis. G Power analysis indicated that a minimum of 133 patients would be required to achieve sufficient statistical power, meaning that the analyses were conducted with a sample size well above the required threshold. Of the 505 patients included in the study, 52.7% were female, and the mean age was 77.6 years (Table 1). Hypertension (42.6%) and chronic obstructive pulmonary disease (20.2%) were the most common underlying conditions (Table 2). A significant proportion (29.3%) of patients had no chronic disease (Table 2), indicating a subgroup with fewer comorbidities but still at risk for elevated CRP levels.

When the complaints of the patients presenting to the ED were categorized, the most common complaints were shortness of breath (28.9%), abdominal pain (10.3%), and

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nausea and vomiting (9.3%) (Table 2). Based on anamnesis, physical examination, and investigations, the clinical conditions of the patients were categorized into infective and non-infective causes. Diagnoses such as pneumonia, urinary tract infection, upper respiratory tract infection, and gastroenteritis were categorized as infective causes, while acute myocardial infarction, cerebrovascular events, and muscle and joint pain were included in the non-infective category. Accordingly, 41.6% of the cases were determined to have infective causes, and 58.4% were classified as non-infectious. It was observed that 55.8% of the patients in both groups had CRP levels between 5 and 50 mg/L (Table 3).

Female	266 (52.7)
Male	239 (47.3)
Mean Age	77.63±8.53
Vital Signs	
Body temperature (°C)	36.57±0.64
Pulse rate (/min)	93.13±20.02
Systolic blood pressure (mmHg)	132.97±30.73
Diastolic blood pressure (mmHg)	76.78±15.95
Saturation (%)	93.42±5.27
Blood Test Results	
Hemoglobin	12.33±2.06
White Blood Cell	9.1 (7.1-11.8)
Neutrophil	6.8 (4.7-9.4)
Platelet	210.0 (168.0-265.5)

Table 1. Demographic characteristics, vital signs and blood test results of the patients

Data are expressed as mean±standard deviation, median (1st quarter-3rd quarter) and n(%).

When CRP levels were compared according to the diagnostic categories, it was observed that patients with CRP levels between 5 and 100 mg/L were mostly diagnosed with non-infective conditions, while those with CRP levels between 101 and 200 mg/L, and those with levels above 200 mg/L, were more commonly diagnosed with infective causes. As CRP levels increased, the likelihood of receiving an infective diagnosis also increased, and this relationship was found to be statistically significant ($p < 0.001$) (Table 3).

CRP LEVEL (mg/L)	5-50	51-100	101-150	151-200	>200	<i>p</i>
Diagnosis	n (%)	n (%)	n (%)	N (%)	n (%)	
Infective causes (n=210)	77 (27.3)	47 (44.3)	34 (59.6)	31 (81.6)	21 (95.5)	
Non-infectious causes (n=295)	205 (72.7)	59 (55.7)	23 (40.4)	7 (18.4)	1 (4.5)	
Consultation Status						
Consultation requested (n=175)	59 (20.9)	35 (33.0)	32 (56.1)	29 (76.3)	20 (90.9)	<0.001
No consultation requested (n=330)	223 (79.1)	71 (67.0)	25 (43.9)	9 (23.7)	2 (9.1)	
Outcome of first presentation to the ED						
Discharged patients (n=374)	239 (84.8)	80 (75.5)	35 (61.4)	18 (47.4)	2 (9.1)	<0.001
Hospitalized patients (n=131)	43 (15.2)	26 (24.5)	22 (38.6)	20 (52.6)	20 (90.9)	
Finalization of patients hospitalized from the ED						
Discharged (n=118)	47 (39.8)	28 (23.7)	15 (12.7)	16 (13.6)	12 (10.2)	0.002
Mortality cases (n=24)	3 (12.5)	2 (8.3)	9 (37.5)	4 (16.7)	6 (25.0)	
Diagnostic categories of patients with mortality						
Infective causes (n=21)	1 (33.3)	2 (100.0)	8 (88.9)	4 (100.0)	6 (100.0)	0.061
Non-infectious causes (n=3)	2 (66.7)	0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)	

Table 3. Outcome status of hospitalized patients according to CRP levels and diagnoses of patients with mortality

CRP: C-Reactive Protein ED: Emergency Department

Medical History	n (%)
Hypertension	215 (42.6)
Chronic Obstructive Pulmonary Disease	102 (20.2)
Coronary Artery Disease	102 (20.2)
Diabetes Mellitus	98 (19.4)
Alzheimer's	41 (8.1)
Chronic Renal Failure	30 (5.9)
Malignancy	24 (4.8)
Cerebrovascular Disease	18 (3.6)
Other	6 (1.1)
No Disease in Medical History	148 (29.3)
Complaints	
Shortness of breath	146 (28.9)
Abdominal Pain	52 (10.3)
Nausea Vomiting	47 (9.3)
Cough	31 (6.1)
Fatigue	25 (5.0)
Chest Pain	23 (4.6)
Change of Consciousness	23 (4.6)
Dizziness	22 (4.4)
Nutrition Disorder	18 (3.6)
Diarrhea	18 (3.6)
Headache	17 (3.4)
Muscle Joint Pain	16 (3.2)
Dysuria	15 (3.0)
High Fever	15 (3.0)
Speech Impairment	9 (1.8)
Sore Throat	9 (1.8)
Lack of strength	5 (1.0)
Syncope	4 (0.8)
Palpitations	4 (0.8)
Bleeding	5 (1.0)

Table 2. Medical history of the cases and complaints at presentation to the emergency department

Of the cases included in the study, 54.9% were admitted to the ED as outpatients, and 43% were brought by ambulance. Only four patients (0.8%) were referred to the ED from another outpatient clinic within the hospital, and seven patients (1.4%) were referred from another hospital. A majority of the patients, 74.1% (374), were discharged from the ED, while 25.9% (131) were hospitalized at the first presentation. Among the hospitalized patients, 72.5% (95) were admitted to the ward, and 27.5% (36) were admitted to the intensive care unit (ICU). Of the discharged patients, 18.7% (70) were readmitted to the hospital within seven days. Among those readmitted, 24.3% (14) were hospitalized during the second admission.

When CRP levels were compared with hospitalization status, it was observed that higher CRP levels were associated with a greater likelihood of hospitalization. Specifically, only 15.2% of patients with CRP levels between 5 and 50 mg/L were hospitalized, while 90.9% of those with CRP levels above 200 mg/L required hospitalization. This association between higher CRP levels and increased hospitalization rates was found to be statistically significant ($p < 0.001$) (Table 3).

When post-hospitalization CRP values of patients who were hospitalized at the first admission were examined, it was observed that 63.4% did not show an increase in CRP. Similarly, when the CRP levels at the second admission of patients who were discharged from the ED and readmitted within 7 days were examined, 57.1% did not show an increase in CRP levels.

When the consultation status of the patients admitted to the ED was analyzed, it was found that consultation was requested for 175 patients. A statistically significant association was observed between higher CRP levels and an increased likelihood of consultation requests. Specifically, 90.9% of patients with CRP levels above 200 mg/L required consultation, compared to only 20.9% of patients with CRP levels between 5 and 50 mg/L ($p < 0.001$) (Table 3).

The average length of hospital stay for patients hospitalized for both infective and non-infective reasons was 7 days. Of these patients, 79.7% were discharged, 16.2% died, and 4.1% were transferred to another hospital.

The total number of patients who were hospitalized at the first presentation to the ED and after the second presentation within seven days was 142. Of these patients, 118 were discharged, while 24 died. Among the patients who died, 79.2% had CRP levels higher than 101 mg/L at the first presentation. In contrast, 63.5% of the discharged patients had CRP levels below 100 mg/L. This significant difference in CRP levels between discharged patients and those who died indicates a strong association between higher CRP levels and increased mortality ($p = 0.002$) (Table 3). Additionally, among the patients who died, 87.5% had infective causes, and 85.7% had CRP levels above 101 mg/L at the time of admission (Table 3).

Discussion

Elevated CRP levels were first identified in the 1980s. However, the lack of a control group in earlier studies limited the ability to make definitive judgments about the usefulness of CRP in detecting infections in elderly patients (7). Years later, Cox et al. demonstrated that elevated CRP

levels on admission to a geriatric ward were significantly associated with a higher prevalence of clinically detected infections (8). Our study confirms the association between elevated CRP levels and poor clinical outcomes in geriatric patients presenting to the emergency department for non-traumatic reasons. These findings extend previous research by demonstrating that CRP levels not only correlate with infection severity but also serve as predictors of hospitalization and mortality in this population. These results suggest that routine CRP measurement could improve risk stratification and management decisions in the emergency setting.

Christ et al. found that the most common presenting complaint of geriatric patients admitted to the ED was altered consciousness (9). In contrast, our study identified shortness of breath as the most common presenting complaint, with altered consciousness ranking seventh. This difference may result from variations in patient populations across study centers.

Singler et al. reported a mean fever of 37.3°C in geriatric patients admitted to the hospital, while Simonetti et al. found normal fever measurements in 36% of pneumonia patients (10,11). In our study, the mean temperature was 36.5°C. This could be due to the inclusion of patients without infection and the slower febrile response in geriatric patients compared to younger populations.

In the study by Hogart et al., a CRP cutoff of 40 mg/L was suggested for geriatric patients suspected of having an infection (12). Sierra et al. proposed a cutoff of 80 mg/L in septic patients, irrespective of age (13). Wester et al. showed that CRP cutoffs varied depending on the microorganism involved (14). In our study, patients with CRP levels above 101 mg/L were more commonly diagnosed with infectious causes. Additionally, patients with CRP levels above 150 mg/L had a higher likelihood of hospitalization. These findings suggest that CRP levels exceeding 100 mg/L warrant careful evaluation for infection, while CRP levels above 150 mg/L should raise concerns about hospitalization. The higher cutoff levels observed in our study may be due to the inclusion of both hospitalized and discharged patients, unlike other studies that focused solely on hospitalized patients.

Short-term elevations in CRP have been linked to mortality in sepsis, as shown by Ryu et al., and in community-acquired pneumonia, as reported by Viasus et al. (15,16). In 1986, Cox et al. were the first to report that pneumonia patients who died had significantly higher CRP levels at the time of hospital admission compared to those who survived (8). Our study is consistent with these findings, showing that CRP levels above 100 mg/L are strongly associated with infectious diagnoses and increased mortality. However, unlike previous studies that focused exclusively on hospitalized patients, our research includes patients discharged from the ED. This provides a broader perspective on how CRP levels can be utilized in decision-making, particularly at the initial presentation in the emergency setting.

Limitations

This study has several limitations. First, its retrospective design may introduce selection bias and limit the ability to

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Conclusion

In conclusion, a statistically significant relationship was observed between CRP levels measured in patients over 65 years of age admitted to the emergency department for non-traumatic reasons and the rates of emergency department consultation and hospitalization. When mortality rates among hospitalized patients were assessed, a significant association was observed between increasing CRP levels and mortality. This study highlights the significant association between elevated CRP levels and key clinical outcomes, such as hospitalization, consultation rates, and mortality, in geriatric patients presenting to the emergency department for non-traumatic reasons. Additionally, CRP levels should be considered an integral part of the decision-making process in geriatric emergency patients. CRP values exceeding 150 mg/L should raise concern for potential infection and the need for hospitalization. Moreover, patients with CRP levels over 101 mg/L should be closely monitored for adverse outcomes, as they are at higher risk for readmission and mortality.

Given the strong correlation between CRP levels and adverse outcomes, incorporating CRP measurements into routine clinical assessments in the emergency department could significantly improve the identification of high-risk geriatric patients. This would allow for earlier interventions, better resource allocation, and potentially improved patient outcomes.

Future research should explore the underlying mechanisms by which CRP levels are elevated in non-infectious conditions and further evaluate their prognostic significance. Additionally, prospective studies evaluating the role of CRP in guiding therapeutic interventions, such as the use of antibiotics or other treatments in the emergency department, could further refine its clinical utility.

Overall, CRP remains a valuable biomarker in the management of geriatric patients, providing crucial insights into patient prognosis and aiding in the timely delivery of appropriate medical interventions. Its continued use in

emergency settings can play a vital role in optimizing patient outcomes and improving the quality of care.

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