ORIGINAL RESEARCH

Mortality Prediction of C-Reactive Protein/Albumin Ratio in Non-Cancer Patients in Palliative Care

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Abstract

Objective: The C-reactive protein/albumin ratio (CAR) is used to assess the severity of inflammation. It can provide prognostic information for many diseases. CAR is a more sensitive predictor of systemic inflammatory status than the separate evaluation of these 2 parameters. In this study, we investigated the ability of CAR to predict mortality in non-cancer patients followed in the palliative care service.

Materials and Methods: Patients admitted to the palliative service between November 1, 2024, and May 1, 2025 were included. Patients with active rheumatological disease, active infection, cancer, or those transferred to other units during the study were excluded. It was a prospective study involving 200 patients.

Results: The median CAR value in the non-survivor group was 4.04 [interquartile range (IQR) 5.05]. This value was 1.89 (2.99) IQR in the survivor group ($p \leq 0.001$). Logistic regression analysis showed that a high CAR value and a diagnosis of cerebrovascular disease (CVD) are risk factors affecting palliative care mortality in non-cancer patients [respectively; odds ratio (OR) = 1.310, $p \leq 0.001$, confidence interval (CI) = 1.121–1.531; OR = 3.359, $p = 0.043$, CI = 1.042–10.832].

Conclusion: A high CAR value and a CVD diagnosis were risk factors for mortality in non-cancer palliative care patients.

Keywords: CAR index, cerebrovascular disease, mortality, non-cancer, palliative care

Introduction

C-reactive protein (CRP) is a biomarker that increases in circulation during inflammation and is detected by blood tests (1). CRP, synthesized in the liver, may be elevated in bacterial, fungal and parasitic infections, trauma, and progressive cancers. CRP values increase within 6–8 hours in proportion to the severity of inflammation (2).

Albumin is an important indicator of nutritional status (3). Albumin is one of the most frequently examined proteins in the diagnosis of malnutrition, and hypoalbuminemia is generally accepted as an indicator of malnutrition (4). Older patients with low albumin levels also experience significant loss of muscle mass. Hypoalbuminemia is associated with poor recovery and high mortality among older individuals who are living in the community, hospitalized, or residing in nursing homes (5).

The CRP/albumin ratio (CAR) increases in inflammatory states. It can predict prognosis in many diseases (6). High CAR levels are indicative of systemic inflammation and adverse cardiovascular events (7). CAR value is a more sensitive predictor of systemic inflammatory status than the separate evaluation of these 2 parameters (8). The CAR value can predict prognosis and disease progression in cancer patients (9).

In addition to cancer patients, many older and debilitated patients receive palliative care. Mortality is high in these patients due to their general condition, advanced age, and underlying comorbidities.

In this study, we investigated the mortality prediction ability of CAR in non-cancer patients followed in the palliative care service. Additionally, the cut-off value of CAR for predicting mortality was investigated.

Materials and Methods

Study Participants

Patients admitted to the palliative service between November 1, 2024 and May 1, 2025 were included. Patients transferred to other units during the study, those with active rheumatological disease, those with an active infection, and those diagnosed with cancer were excluded from the study. During the study period, 240 patients were admitted; 40 patients were excluded, and the study continued with the remaining 200 patients. Two hundred patients were followed prospectively in the palliative care unit until discharge or death.

Data Collection

Patients' age, gender, medical information, medical history, number of days of hospitalization, and laboratory values were recorded. Laboratory values of the patients during the first 24 hours in the palliative care service were recorded. Patients were followed up prospectively and divided into 2 groups as surviving or non-surviving patients according to their final status. The survivor group consisted of patients who were discharged from the palliative care service, and the non-survivor group consisted of patients who died in the palliative care service. The causes of death among our patients who died in the palliative care service were generally infections (e.g., pneumonia, bacteremia, infected decubitus ulcers) or other conditions such as heart failure, renal failure, and pulmonary edema. The CAR value was calculated as the ratio of CRP (mg/dL) to albumin (g/dL) from laboratory results obtained within the first 24 hours (10). The Nutrition Risk Screening 2002 (NRS-2002) was used to assess the nutritional status of patients. The NRS-2002 is a malnutrition assessment system developed by the European Society of Clinical Nutrition and Metabolism in 2002 and is frequently used among hospitalized patients. According to the NRS 2002 scoring system, patients with a score of ≥3 are classified as at higher risk for malnutrition, and those with a score of <3 are classified as normal (11). According to NRS 2002, patients at risk of malnutrition were given oral, enteral, and parenteral nutritional support depending on the patients' conditions.

Ethical Statement

Informed consent was obtained from the patient's relatives. An application was submitted to the Ordu University Non-Commercial Scientific Research Ethics Committee, and study approval was obtained (decision number: 2024/139, date: 11.10.2024).

Statistics

IBM SPSS version 23 was used for statistical analysis. In the text, normally distributed numerical variables were expressed as mean ± standard deviation (SD). Non-normally distributed numerical variables were expressed as median [interquartile range (IQR)].

Categorical variables were expressed as numbers (percentages). Comparisons of normally distributed numerical variables were performed with the Student's t-test, and comparisons of non-normally distributed numerical variables were performed with the Mann-Whitney U test. Comparisons of categorical variables were performed using the chi-square (χ^2) test or Fisher's exact test. The sample size for the study was determined using G*Power analysis. The α coefficient was 0.05, and the sample size was calculated to be 184 when the effect size was assumed to be 0.5. Risk factors affecting mortality in non-cancer palliative care patients were determined by logistic regression analysis. Parameters with p-values in Table 1 were included in the regression analysis. If any parameters were highly correlated, only one was included in the regression analysis. The cut-off value of CAR for predicting mortality was determined using receiver operating characteristic (ROC) curve analysis. Sensitivity, specificity, and area under the curve were calculated. Youden's index was used to determine the optimal cut-off value. p-value ≤ 0.05 was considered as statistically significant.

Results

The median age of the patients was 83 years (IQR 12). Fifty-two percent of the patients were women. The median CRP value was 10.9 (9.5) IQR in the non-surviving group and 4.7 (7.7) IQR in the surviving group (p ≤ 0.001). The median procalcitonin value was 0.2 (IQR 0.59) in the non-survivor group and 0.13 (IQR 0.13) in the survivor group (p = 0.009). The median CAR value was 4.04 (5.05) IQR in the non-survivor group and 1.89 (2.99) IQR in the survivor group (p ≤ 0.001). A diagnosis of CVD was present in 82% of the non-survivor group versus 57% of the survivor group (p = 0.024). The general characteristics of the patients are presented in Table 1.

Risk factors affecting mortality in non-cancer palliative care patients were investigated using logistic regression analysis. The parameters that have a p-value of <0.200 in Table 1 were included in the regression analysis. Logistic regression analysis showed that having a high CAR value and CVD diagnosis were risk factors affecting palliative care mortality in non-cancer patients (respectively; OR = 1.310, p = ≤0.001, CI = 1.121–1.531; OR = 3.359, p = 0.043, CI = 1.042–10.832). Due to the high correlation of CRP, albumin, and albumin/procalcitonin valueswith other parameters, these parameters were not included in the regression analysis. The results are presented in Table 2.

ROC curve analysis showed that the CAR cut-off point for predicting mortality in non-cancer palliative care patients was 3.25 (sensitivity = 68%, specificity = 71%) (Figure 1).

Discussion

Our study showed that a high CAR value and a diagnosis of CVD were risk factors for palliative care mortality among non-cancer. patients. The cut-off point of CAR for predicting

Table 1. Characteristics of the patients.

	Total n = 200	Non-survivor n = 22 (11%)	Survivor n = 178 (89%)	p
Sex				
Women, n (%)	104 (52%)	11 (50%)	93 (52%)	0.842
Age (IQR)	83 (12)	83 (16)	83 (12)	0.527
Follow-up days, n (IQR)	13 (13)	18 (15)	12 (13)	0.073
Pressure ulcer, n (%)	160 (80%)	21 (96%)	139 (78%)	0.085
NRS-2002 score (IQR)	5 (2)	5 (1)	5 (2)	0.332
Laboratory findings				
Hemoglobin, g/dL (IQR)	9.9 (2.3)	9.8 (2.6)	9.9 (2.3)	0.403
CRP, mg/dL (IQR)	5.35 (8.1)	10.90 (9.5)	4.70 (7.7)	≤0.001
Albumin, g/dL ± SD	2.76 ± 0.48	2.58 ± 0.41	2.78 ± 0.48	0.063
Prealbumin, mg/dL (IQR)	12.6 (7.4)	12.15 (9.8)	12.6 (7.3)	0.214
Procalcitonin, µg/L (IQR)	0.14 (0.21)	0.2 (0.59)	0.13 (0.13)	**0.009**
CAR (IQR)	2.02 (3.21)	4.04 (5.05)	1.89 (2.99)	≤0.001
CRP/prealbumin (IQR)	0.47 (1.01)	0.84 (1.34)	0.40 (0.91)	≤0.001
Albumin/procalcitonin (IQR)	21 (21)	13 (19)	22 (23)	**0.006**
Prealbumin/procalcitonin (IQR)	80 (120)	50 (71)	86 (131)	**0.005**
Comorbidities				
Dementia, n (%)	119 (60%)	12 (55%)	107 (60%)	1.000
CVD, n (%)	119 (60%)	18 (82%)	101 (57%)	**0.024**
DM, n (%)	58 (29%)	5 (23%)	53 (30%)	0.492
HT, n (%)	98 (49%)	13 (59%)	85 (48%)	0.316

n: Number; IQR: Interquartile range, NRS-2002: Nutritional risk screening 2002, SD: Standard deviation, CRP: C-reactive protein, CAR: CRP/albumin ratio, CVD: Cerebrovascular disease, DM: Diabetes mellitus, HT: Hypertension.

Table 2. Logistic regression analysis results*.

	OR	p	CI
CAR	1.310	≤0.001	1.121–1.531
CVD	3.359	0.043	1.042–10.832

*Age, sex, follow-up days, CVD, pressure ulcer, CAR, CRP/prealbumin, prealbumin/procalcitonin, procalcitonin.
CI: Confidence interval, OR: Odds ratio, CRP: C-reactive protein, CAR: CRP/albumin ratio, CVD: Cerebrovascular disease.

mortality in non-cancer patients in palliative care was determined to be 3.25.

Many studies have investigated CAR and demonstrated its relationship with mortality and morbidity in various diseases. Piñerúa-Gonsálvez et al. (12) found that a high CAR value was a risk factor for severe acute pancreatitis. In their study, Aydın and Kaçmaz (13) showed that a high CAR is a risk factor for postoperative intensive care unit admission and 1-year postoperative mortality among older patients undergoing hip fracture surgery. In their study, Yildirim et al. (14) showed that high CAR values are risk factors for severe carotid artery stenosis. Arakawa et al. (15) found that high CAR levels were associated with advanced T stage in patients with resectable pancreatic cancer. The studies we have exemplified show that

CAR can provide information on mortality and morbidity across different diseases. Many patients without cancer are followed in palliative care services. Many of these patients may be older and diagnosed with dementia or CVD. The mortality rate is high in this patient group. Multiple risk factors for mortality exist in these patient groups. Hsieh et al. (16) showed that pneumonia, severe decubitus ulcers, a 25% or greater reduction in food intake, treatment for electrolyte imbalance, oxygen requirement, and long-term urinary catheters were 6-month prognostic indicators in patients with advanced dementia living in long-term care facilities. Sakai et al. (17) showed that complete dependence on oral feeding and hypoalbuminemia were risk factors for mortality among patients with advanced dementia receiving palliative care. van Voorden et al. (18) showed that deaths in patients with dementia are most often due to dehydration and
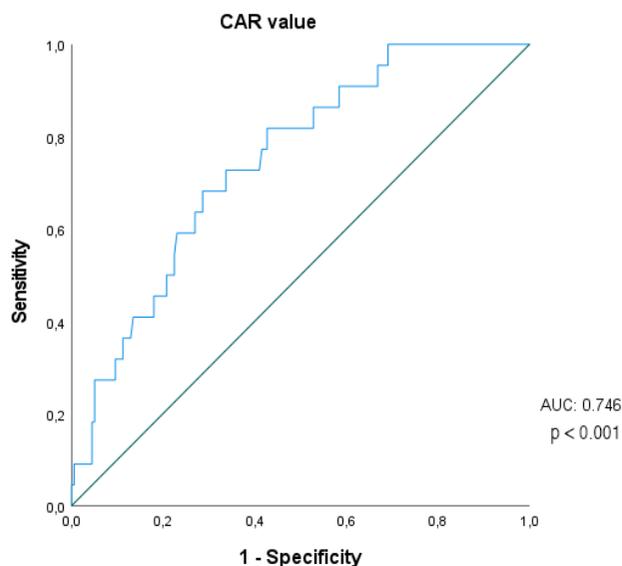
Figure 1. ROC curve analysis examining the cut-off point of CAR* [AUC (95 % CI): 0.746 (0.649–0.843), cut-off: 3.25, p < 0.001, sensitivity: 68%, specifity: 71%, Youden's Index: 0.395].

*: Cut-off value that corresponded to the highest Youden's index in the ROC curve analysis.

ROC: Receiver operating characteristic, CAR: C-reactive protein/albumin ratio, CI: Confidence interval, AUC: Area under the curve.

pneumonia. They showed that mortality was most accurately predicted by being aged 80 and above and by the number of medications used (18). In our study, we showed that mortality in these patients can be predicted by examining the CAR index. We used the CRP and albumin values of the patients examined within the first 24 hours in the palliative care service. CRP and albumin are parameters that are easily and routinely measured in many hospital laboratories. The CAR index is an simple test that can guide us in prognostication of non-cancer patients followed in the palliative service. Additionally, this study showed that the CAR cut-off value for predicting mortality in non-cancer patients receiving palliative care was 3.25. In the study, the CRP/prealbumin, prealbumin/procalcitonin, and albumin/procalcitonin ratios were also investigated for their effects on mortality, but their effects were not demonstrated.

A diagnosis of CVD was also a risk factor for mortality among palliative care patients. Stroke can lead to high rates of mortality and morbidity. This may be due to medical complications related to the neurological disorder, direct effects of severe brain injury, or underlying diseases that caused the stroke. Palliative care may be needed in stroke patients for reasons such as respiratory distress, pain, and respiratory tract secretions (19). In the study by Saricam et al. (20), palliative care mortality among stroke patients was 20.5%. In this study, stroke patients were classified into 3 groups: ischemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage. In this study, we did not divide CVD patients into subgroups. Mortality among CVD patients receiving

palliative care was 15%. However, in our study, 82% of the non-survivors had a diagnosis of CVD. We have shown that the diagnosis of CVD increases mortality risk in non-cancer patients receiving palliative care.

Our study had several strengths. In this study, 200 patients were followed prospectively for 6 months. Furthermore, palliative care studies in the literature generally focus on cancer patients. Another key strength of this study is its focus on non-cancer patients in palliative care.

Study Limitatons

Our study had limitations. First, we observed only patients in palliative care, so follow-up periods were short. Studies can be conducted that include patients who were discharged and transferred to other units and that provide longer-term follow-up. Second, we conducted this study at a single center; studies involving multiple centers can be conducted to increase the generalizability of the results.

Conclusion

This study showed that a high CAR value and a diagnosis of CVD are risk factors for mortality in non-cancer patients in palliative care. The cut-off value of the CAR to predict mortality was found to be 3.25.

Conflict of Interest: The authors declare no conflicts of interest.

Financial Disclosure: The authors declared that this study received no financial support.

Ethics

Ethics Committee Approval: An application was submitted to the Ordu University Non-Commercial Scientific Research Ethics Committee, and study approval was obtained (decision number: 2024/139, date: 11.10.2024).

Informed Consent: Informed consent was obtained from the patient's relatives.

Footnotes

Conflict of Interest: No conflict of interest was declared by the author.

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