ORIGINAL ARTICLE

Regression analysis for intensive care unit (ICU) admission prediction in elderly patients with acute appendicitis

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ABSTRACT

BACKGROUND: Acute appendicitis in the elderly often presents with atypical symptoms and is frequently complicated at diagnosis, potentially requiring intensive care unit (ICU) admission. Early risk identification is essential for effective triage. Hematologic biomarkers may provide rapid, accessible tools for predicting disease severity. The objective of this study was to evaluate the predictive value of hematologic parameters—particularly lymphocyte count, neutrophil-to-lymphocyte ratio (NLR), and immature granulocyte (IG) indices—for ICU admission and complicated appendicitis in elderly patients.

METHODS: This retrospective observational study included patients aged ≥65 years who underwent appendectomy for suspected acute appendicitis between 2018–2021 and in 2024 at a tertiary emergency department. Patients were grouped by ICU admission status and histopathological diagnosis (complicated vs. non-complicated appendicitis). Preoperative clinical and laboratory data were analyzed using logistic regression and receiver operating characteristic (ROC) analysis. A post hoc power analysis was also performed.

RESULTS: Of 143 patients included, 33 (23.1%) required ICU admission. These patients were older and had higher rates of diabetes and coronary artery disease. Lymphocyte counts were significantly lower and NLR values higher in the ICU group. In multivariate analysis, only lymphocyte count independently predicted ICU admission. Complicated appendicitis was associated with age, diabetes, low lymphocyte count, high IG%, and elevated NLR in univariate analysis; however, only age, diabetes, and lymphocyte count remained significant in multivariate modeling. ROC analysis showed moderate diagnostic performance for lymphocyte count (area under the curve=0.669) in identifying complicated cases.

CONCLUSION: Lymphopenia is an independent predictor of ICU admission and complicated appendicitis in elderly patients. Routine blood parameters may support early clinical risk stratification in emergency settings.

Keywords: Acute appendicitis; elderly; intensive care unit; emergency department.

INTRODUCTION

Acute appendicitis remains one of the most frequent causes of emergency abdominal surgery worldwide, and its management in elderly patients presents unique challenges. Patients over 65 years of age often present with atypical clinical features, delayed diagnoses, and face a higher risk of severe complications such as perforation, abscess formation, and peritonitis, which can necessitate intensive care unit (ICU) admission. Identifying elderly patients at risk of clinical deterioration who may require ICU care is crucial for optimizing resource allocation and improving outcomes. Previous studies report that the incidence of complicated appendicitis in elderly patients can be as high as 50%–70% at the time of diagnosis.[1,2]

Timely and accurate differentiation between complicated and non-complicated appendicitis is essential in elderly patients, not only to avoid treatment delays but also to optimize out-

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comes and reduce mortality. Imaging modalities such as computed tomography (CT) play a central role in diagnosis; however, limitations including radiation exposure, contrast-related risks, and delays in imaging availability make laboratory biomarkers an attractive adjunct. While CT scans are invaluable for diagnosing appendicitis and assessing severity, their availability and timeliness can be limited, particularly in emergency departments (EDs). Consequently, there is growing interest in simple, rapidly obtainable laboratory biomarkers that could aid in early risk stratification.[3,4]

Recent attention has focused on hematologic parameters as potential diagnostic and prognostic tools. Hematologic parameters derived from routine blood tests, including white blood cell counts, neutrophil-to-lymphocyte ratio (NLR), and lymphocyte counts, have been investigated as potential predictors of disease severity in various inflammatory and infectious conditions.[5-7] Lymphopenia, in particular, has been recognized as a marker of immunosuppression and poor prognosis in critical illnesses.[8] Immature granulocytes (IGs)—a subset of neutrophils that includes metamyelocytes, myelocytes, and promyelocytes—have emerged as promising indicators of systemic inflammation and infection. IG counts can now be readily measured by automated hematology analyzers as part of a routine complete blood count with differential, providing rapid and cost-effective information.[9,10] Increased IG levels have been associated with bacterial infections, sepsis, and other inflammatory conditions, and preliminary evidence suggests that IGs may help distinguish complicated from uncomplicated intra-abdominal infections.[11,12] However, data specifically evaluating the utility of IGs in the differential diagnosis of complicated appendicitis among elderly patients remain limited.

Despite this, limited data exist regarding the predictive value of these hematologic markers for ICU admission specifically in elderly patients with acute appendicitis. This study aims to evaluate various hematologic parameters as predictors of ICU admission in this high-risk population, with a focus on identifying the most significant and practical biomarker(s) for early clinical decision-making.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational and multidisciplinary study was conducted in the ED of a tertiary care university hospital. The study was approved by the institutional ethics committee (approval number: 21, date: 25/02/2025) and carried out in accordance with the principles of the Declaration of Helsinki.

Study Population

Patients aged 65 years and older who presented to the ED and underwent surgery with a pre-diagnosis of acute appendicitis were included in the study. The study period covered two separate intervals: January 1, 2018 to December 31, 2021, and January 1, 2024 to December 31, 2024, totaling five years. The period between January 1, 2022 and January 1, 2024 was excluded from the study due to disruptions in clinical practice caused by the Coronavirus Disease 2019 (COVID-19) pandemic.

Inclusion and Exclusion Criteria

Inclusion criteria were:

1. Age ≥65 years,
2. Appendectomy performed for suspected acute appendicitis,
3. Histopathological confirmation of appendicitis, and
4. Availability of complete preoperative laboratory and clinical data.

Patients were excluded if they had incomplete medical records, hematologic malignancies, active immunosuppressive therapy, chronic inflammatory diseases, or if surgery occurred during the COVID-19 exclusion period.

Multidisciplinary Approach

This study adopted a multidisciplinary approach. All patients were initially evaluated by ED physicians upon admission. Surgical indications were determined by the general surgery team based on clinical, radiological, and laboratory findings. Postoperative ICU requirements were assessed and confirmed by anesthesiology specialists, ensuring that ICU admissions reflected standardized criteria based on intraoperative and postoperative hemodynamic and respiratory status.

Data Collection

Demographic information (age, sex), comorbidities (hypertension (HT), diabetes mellitus (DM), coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), chronic kidney disease (CKD), cerebrovascular disease (CVD), clinical parameters (ICU admission, vasopressor use), radiological findings (ultrasound (USG) and computed tomography results), and preoperative laboratory values were retrospectively collected from the hospital's electronic medical records. All laboratory parameters analyzed in this study were obtained from blood samples collected at the time of ED admission, prior to surgical intervention. No serial or follow-up blood tests were performed for comparative purposes during the inpatient stay or postoperative period. The analysis was therefore limited to initial laboratory findings upon presentation. Laboratory variables included white blood cell count (WBC, $\times 10^3$/L), neutrophil count ($\times 10^3$/L) and percentage (%), lymphocyte count ($\times 10^3$/L), platelet count (PLT, $\times 10^3$/L), neutrophil-to-lymphocyte ratio, immature granulocyte count ($\times 10^9$/L), immature granulocyte percentage (IG%), C-reactive protein (CRP, mg/dL), lactate (mmol/L), anion gap (mmol/L), prothrombin time (PT, sec), PT percentage (PT%), international normalized ratio (INR), and activated partial thromboplastin time (aPTT,

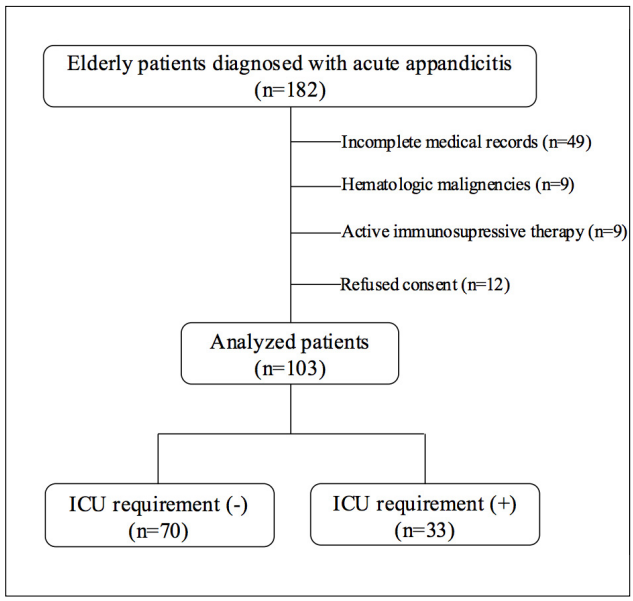

Figure 1. Study flowchart

sec). Hematological parameters were assessed using a hematology analyser (Cell-Dyne 3700, Abbott Park, IL, USA), and biochemical levels were assessed with the Beckman Coulter AU5800 analyzer (Beckman Coulter, Inc., Fullerton, USA).

Definitions and Grouping

Patients were classified into two groups based on their postoperative clinical course: those admitted to the ICU and those who were not. Additionally, patients were categorized as having simple or complicated appendicitis according to histopathological examination results. Cases diagnosed as simple (acute) appendicitis on histopathology were classified as non-complicated appendicitis, whereas cases reported as gangrenous or perforated appendicitis were classified as complicated appendicitis. This pathological classification was used as the reference standard for subgroup analyses in the study.

Statistical Analysis

Statistical analysis was performed using statistical package (v25.0; SPSS Inc., Chicago, IL). Continuous variables were presented as mean±standard deviation (SD) or median (interquartile range [IQR]), depending on distribution, and categorical variables were expressed as frequencies and percentages. Comparisons between groups were conducted using the independent-samples t-test or Mann-Whitney U test for continuous variables, and the chi-square test for categorical variables. Univariate logistic regression was used to assess potential predictors of ICU admission and complicated appendicitis. Variables with $p<0.10$ in univariate analysis were included in the multivariate logistic regression model. Receiver operating characteristic (ROC) analysis was performed to evaluate diagnostic performance and determine cutoff values. A p-value <0.05 was considered statistically significant.

Table 1. Patients characteristics, symptoms, and clinical outcomes

Number of patients, n (%)	103 (100.0)
Age, years	70 (67-75)
Male, n (%)	49 (47.6)
Comorbidities, n (%)	
HT	50 (48.5)
DM	24 (23.3)
COPD	16 (15.5)
CHF	8 (7.8)
CAD	5 (4.9)
CVD	3 (2.9)
CKD	3 (2.9)
Laboratory values (initial)	
WBC (×10³/L)	12.1±4.6
Neuc (×10³/L)	9.6±4.3
Neu, (%)	79.1 (70.4-84.9)
Lymc (×10³/L)	1.55 (1.06-2.00)
NLR	5.9 (3.4-9.5)
IG, (×10⁹/L)	0.04 (0.02-0.07)
IG, (%)	0.40 (0.20-0.50)
PLT (×10³/L)	233 (195-268)
PLCR	27 (22-31)
CRP, (mg/dL)	49.2 (11.7-165.7)
aPTT (sec)	26 (24-29)
INR	1.0 (1.0-1.1)
PT (sec)	12.5 (11.6-14.6)
PT, (%)	95 (81-106)
AG, (mmol/L)	12 (6-17)
Lactate, (mmol/L)	2.0 (1.3-2.8)
Pathological sign in USG, n (%)	11 (10.7)
Pathological sign in CT, n (%)	77 (74.8)
Complicated appendicitis, n (%)	32 (31.1)
Vasopressor support, n (%)	6 (5.8)
ICU requirement, n (%)	33 (32.0)

aPTT: Activated partial thromboplastin time; AG: Anion gap; CAD: Coronary artery disease; CHF: Congestive heart failure; CKD: Chronic kidney disease; COPD: Chronic obstructive pulmonary disease; CRP: C-reactive protein; CT: Computed tomography; CVD: Cerebrovascular disease; DM: Diabetes mellitus; HT: Hypertension; ICU: Intensive care unit; IG: Immature granulocyte; INR: International normalized ratio; Lymc: Lymphocyte count; Neuc: Neutrophil count; NLR: Neutrophil-to-lymphocyte ratio; PLCR: Platelet large cell ratio; PLT: Platelet count; PT: Prothrombin time; USG: Ultrasonography; WBC: White blood cell count.

Statistical Power Analysis

A post hoc power analysis was conducted based on the final sample size of 103 patients, with 33 patients requiring ICU admission and 70 not requiring ICU care. Assuming a large effect size (Cohen's d=0.8), a two-tailed test, and a significance

level of α=0.05, the calculated power (1–β) was approximately 96%. This suggests that the study had sufficient statistical power to detect moderate differences between groups.

RESULTS

Study Population

A total of 103 elderly patients diagnosed with acute appendicitis were included in the study (Fig. 1). Patients were stratified based on ICU admission status and presence of complicated appendicitis. Thirty-three patients were admitted to the ICU (32%), and 32 patients (31.1%) were classified as having complicated appendicitis (Table 1).

Baseline Characteristics

Among the included patients, 54 (52.4%) were female, and

Table 2. Comparison of parameters between intensive care unit (ICU) requirements (-) and (+) groups

	ICU Requirements (-) (n=70)	ICU Requirements (+) (n=33)	p
Age, years	70 (66-72)	74 (70-82)	<0.001
Male, n (%)	29 (41.4)	20 (60.6)	0.069
Comorbidities, n (%)			
HT	31 (44.3)	19 (57.6)	0.208
DM	12 (17.1)	12 (36.4)	0.031
COPD	11 (15.7)	5 (15.2)	0.941
CHF	6 (8.6)	2 (6.1)	0.657
CAD	1 (1.4)	4 (12.1)	0.035
CVD	2 (2.9)	1 (3.0)	1.000
CKD	1 (1.4)	2 (6.1)	0.240
Laboratory values (initial)			
WBC (×10^3/L)	12.0±4.8	12.4±4.1	0.728
Neuc (×10^3/L)	9.4±4.6	10.2±3.9	0.341
Neu, (%)	75.4±10.0	81.9±6.3	<0.001
Lymc (×10^3/L)	1.64 (1.20-2.17)	1.37 (0.87-1.68)	0.021
NLR	5.1 (2.9-9.0)	7.6 (5.5-10.2)	0.016
IG, (×10^9/L)	0.04 (0.02-0.07)	0.06 (0.03-0.08)	0.284
IG, (%)	0.40 (0.20-0.50)	0.50 (0.25-0.55)	0.210
PLT (×10^3/L)	237 (195-269)	229 (192-271)	0.447
PLCR	26.9±7.7	29.3±10.0	0.182
CRP, (mg/dL)	42.7 (11.2-134.0)	61.8 (10.5-312.4)	0.418
aPTT (sec)	25 (24-28)	28 (24-30)	0.096
INR	1.0 (0.9-1.1)	1.1 (1.0-1.3)	0.001
PT (sec)	12.2 (11.4-14.1)	14.4 (12.4-16.9)	<0.001
PT, (%)	96±17	85±18	0.004
AG, (mmol/L)	11.0±5.9	12.5±5.5	0.477
Lactate, (mmol/L)	1.8±0.7	2.3±1.2	0.160
Pathological sign in USG, n (%)	8 (11.4)	3 (9.1)	1.000
Pathological sign in CT, n (%)	53 (75.7)	24 (72.7)	0.745
Complicated appendicitis, n (%)	15 (21.4)	17 (51.5)	0.002
Vasopressor support (perioperative), n (%)	0 (0.0)	6 (18.2)	<0.001

aPTT: Activated partial thromboplastin time; AG: Anion gap; CAD: Coronary artery disease; CHF: Congestive heart failure; CKD: Chronic kidney disease; COPD: Chronic obstructive pulmonary disease; CRP: C-reactive protein; CT: Computed tomography; CVD: Cerebrovascular disease; DM: Diabetes mellitus; HT: Hypertension; ICU: Intensive care unit; IG: Immature granulocyte; INR: International normalized ratio; Lymc: Lymphocyte count; Neuc: Neutrophil count; NLCR: Neutrophil-to-lymphocyte ratio; PLCR: Platelet large cell ratio; PLT: Platelet count; PT: Prothrombin time; USG: Ultrasonography; WBC: White blood cell count.

the median age was 70 years (IQR 67-75). The most common comorbidities were HT (n=50, 48.5%), DM (n=24, 23.3%), and COPD (n=16, 15.5%). While all patients were diagnosed histopathologically with acute appendicitis, 11 patients (10.7%) were diagnosed using USG and 77 patients (74.8%) with CT. Vasopressor support was required in only six patients (5.8%) (Table 1).

Comparison Between ICU and Non-ICU Groups

Patients admitted to the ICU (n=33) were significantly older than those who were not (p<0.001), while gender distribution did not differ significantly between groups (p=0.069). The rate of vasopressor use was significantly higher in the ICU group (p<0.001). Regarding comorbidities, DM and CAD were more prevalent among ICU-admitted patients (p=0.031

Table 3. Comparison of parameters between non-complicated and complicated appendicitis groups

	Non-Complicated Group (n=71)	Complicated Group (n=32)	p
Age, years	69 (67-72)	74 (70-81)	<0.001
Male, n (%)	32 (45.1)	17 (53.1)	0.449
Comorbidities, n (%)			
HT	34 (47.9)	16 (50.0)	0.843
DM	12 (16.9)	12 (37.5)	0.022
COPD	11 (15.5)	5 (15.6)	0.986
CHF	6 (8.5)	2 (6.3)	1.000
CAD	2 (2.8)	3 (9.4)	0.172
CVD	1 (1.4)	2 (6.3)	0.227
CKD	1 (1.4)	2 (6.3)	0.227
Laboratory values (initial)			
WBC ($\times10^3$/L)	12.0±4.3	12.4±5.2	0.703
Neuc ($\times10^3$/L)	9.4±4.1	10.2±4.8	0.340
Neu, (%)	77.1 (67.0-84.7)	82.3 (77.5-86.5)	0.014
Lymc ($\times10^3$/L)	1.63 (1.22-2.23)	1.35 (0.84-1.66)	0.006
NLR	5.1 (2.9-9.3)	7.6 (5.5-10.4)	0.007
IG, ($\times10^9$/L)	0.04 (0.02-0.07)	0.05 (0.03-0.11)	0.153
IG, (%)	0.40 (0.20-0.50)	0.50 (0.23-0.68)	0.020
PLT ($\times10^3$/L)	238 (195-279)	220 (188-265)	0.247
PLCR	26.9±7.4	29.3±10.4	0.195
CRP, (mg/dL)	48.4 (10.5-105.7)	165.7 (30.0-332.5)	0.118
aPTT (sec)	26 (24-29)	26 (23-29)	0.641
INR	0.9 (0.9-1.0)	1.0 (0.9-1.0)	0.089
PT (sec)	12.4 (11.4-14.4)	13.0 (11.8-15.9)	0.149
PT, (%)	96 (84-107)	95 (68-104)	0.092
AG, (mmol/L)	10.8±5.3	13.4±5.9	0.208
Lactate, (mmol/L)	1.7±0.8	2.6±1.2	0.031
Pathological sign in USG, n (%)	7 (9.9)	4 (12.5)	0.735
Pathological sign in CT, n (%)	54 (76.1)	23 (71.9)	0.651
Vasopressor support, n (%)	2 (2.8)	4 (12.5)	0.073
ICU requirement, n (%)	16 (22.5)	17 (53.1)	0.002

aPTT: Activated partial thromboplastin time; AG: Anion gap; CAD: Coronary artery disease; CHF: Congestive heart failure; CKD: Chronic kidney disease; COPD: Chronic obstructive pulmonary disease; CRP: C-reactive protein; CT: Computed tomography; CVD: Cerebrovascular disease; DM: Diabetes mellitus; HT: Hypertension; ICU: Intensive care unit; IG: Immature granulocyte; INR: International normalized ratio; Lymc: Lymphocyte count; Neuc: Neutrophil count; PLCR: Platelet large cell ratio; PLT: Platelet count; PT: Prothrombin time; USG: Ultrasonography; WBC: White blood cell count.

Table 4. Receiver operating characteristic (ROC) analysis for intensive care unit (ICU) requirements

	Cut-off value	Sen.	Spec.	PPV	NPV	AUC (95% CI)	p
Age, years	>73	0.61	0.79	0.57	0.81	0.73 (0.62-0.83)	<0.001
PT (sec)	>12.3	0.82	0.56	0.47	0.87	0.71 (0.60-0.82)	<0.001
INR	>1.1	0.42	0.89	0.64	0.77	0.70 (0.58-0.82)	0.001
Neu (%)	>78.1	0.85	0.59	0.49	0.89	0.69 (0.59-0.80)	<0.001
PT (%)	<83	0.52	0.84	0.61	0.79	0.68 (0.56-0.80)	0.003
NLCR	>5.1	0.79	0.50	0.43	0.83	0.65 (0.54-0.76)	0.008
Lymc (×10³/L)	<1.48	0.67	0.63	0.46	0.80	0.64 (0.53-0.75)	0.013

INR: International normalized ratio; Lymc: Lymphocyte count; Neu: Neutrophil count; NLCR: Neutrophil-to-lymphocyte ratio; PT: Prothrombin time.

Table 5. Receiver operating characteristic (ROC) analysis for intensive care unit (ICU) requirements

	Cut-off value	AUC (95% CI)	p
Age, years	>73	0.73 (0.62-0.83)	<0.001
PT (sec)	>12.3	0.71 (0.60-0.82)	<0.001
INR	>1.1	0.70 (0.58-0.82)	0.001
Neu (%)	>78.1	0.69 (0.59-0.80)	<0.001
PT (%)	<83	0.68 (0.56-0.80)	0.003
NLR	>5.1	0.65 (0.54-0.76)	0.008
Lymc (×10³/L)	<1.48	0.64 (0.53-0.75)	0.013

INR: International normalized ratio; Lymc: Lymphocyte count; Neu: Neutrophil; NLCR: Neutrophil-to-lymphocyte ratio; PT: Prothrombin time.

and p=0.035, respectively), whereas no significant differences were observed for HT, CKD, COPD, CVD, or CHF (p>0.05) (Table 2).

Laboratory findings showed that lymphocyte counts were significantly lower and neutrophil percentages significantly higher in the ICU group (p=0.021 and p<0.001, respectively). WBC, platelet counts, and absolute neutrophil counts did not differ significantly (p>0.05). The ICU group also had significantly higher NLR values (p=0.016), but no significant differences were observed in IG count, IG%, or platelet large cell ratio (PLCR) values (p>0.05). Among coagulation and biochemical parameters, PT and INR were significantly higher, while PT% was significantly lower in ICU patients (p<0.001, p=0.001, and p=0.004, respectively). No significant differences were found in CRP, aPTT, lactate, or anion gap values (p>0.05). Radiological findings (USG or CT) did not differ significantly between groups (p>0.05). However, the rate of complicated appendicitis was significantly higher among patients admitted to the ICU (p=0.002) (Table 2).

Comparison Between Complicated and Non-Complicated Groups

When comparing patients with complicated versus non-complicated appendicitis, the complicated group was significantly older (p<0.001), but no significant differences were observed in gender or vasopressor use (p>0.05) (Table 3). DM was significantly more common in patients with complicated appendicitis (p=0.022), while other comorbidities did not differ significantly (p>0.05). Lymphocyte counts were significantly lower, and neutrophil percentages, NLR, and IG% were higher in the complicated group (p=0.006, p=0.014, p=0.007, and p=0.020, respectively), whereas other laboratory parameters showed no significant differences (p>0.05). Lactate levels were also significantly elevated in complicated cases (p=0.031), but no significant differences were observed in anion gap (p>0.05). Radiologic findings (USG and CT) did not differ significantly between groups (p>0.05).

Regression and ROC Analysis

In the multivariate logistic regression model with Youden's index for the likelihood of ICU requirement, age ≥73 years (p=0.011), PT ≥12.3 sec (p=0.016), neutrophil percentage ≥78.1% (p=0.025), and presence of DM (p=0.039) remained independent predictors of ICU admission (Table 4). Presence of CAD, complicated appendicitis, NLR, PT%, INR, and lymphocyte count were not predictive of ICU admission. ROC analysis for ICU requirements revealed that age (>73 years), PT (>12.3 sec), INR (>1.1), neutrophil percentage (>78.1),

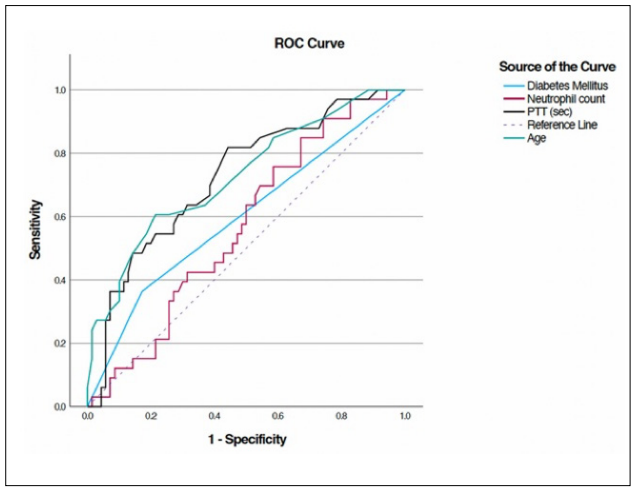

Figure 2. Decision curve analysis of candidate predictors for intensive care unit (ICU) admission in elderly patients with acute appendicitis.

PT% (<83), NLR (>5.1), and lymphocyte count (<1.48 ×103/L) demonstrated moderate diagnostic performance in identifying ICU admission with the following areas under the curve (AUCs) (95% confidence interval (CI)): 0.73 (0.62-0.83), 0.71 (0.60-0.82), 0.70 (0.58-0.82), 0.69 (0.59-0.80), 0.68 (0.56-0.80), 0.65 (0.54-0.76), and 0.64 (0.53-0.75), respectively (Table 5, Figure 2).

DISCUSSION

Several recent studies have investigated the role of hematologic markers in identifying complicated appendicitis, and our findings contribute to this growing body of evidence, particularly in the elderly population. In our study, although a low lymphocyte count was significantly associated with ICU admission in univariate analysis, it did not remain an independent predictor in the multivariable model. Instead, age, PT, neutrophil percentage, and diabetes mellitus were identified as independent prognostic indicators in elderly patients with acute appendicitis.

Our results are in line with those of Uludag et al., who evaluated 702 patients with histologically confirmed appendicitis and reported that low lymphocyte count, elevated CRP, and increased NLR were strong predictors of perforation. [12] Specifically, a lymphocyte count below 1.7/mm³ and an NLR above 7.65 were significantly associated with complicated appendicitis. These findings emphasize the diagnostic importance of lymphocyte depletion as a marker of systemic inflammation and disease severity, which may be especially valuable in elderly patients who often present with atypical or nonspecific symptoms.

Similarly, a large-scale retrospective study by Sevinc et al. involving 3,392 patients found that NLR and serum bilirubin were independent predictors of perforated appendicitis.[13] While WBC was useful in identifying acute appendicitis, it was not significantly associated with perforation. An NLR cut-off of 4.8 demonstrated a sensitivity of 81.2% and specificity of 53.1% for detecting complicated cases, indicating moderate diagnostic value. These results support our findings, in which elevated NLR values were more commonly observed in patients with complicated appendicitis. The defined threshold of 4.8 may serve as a clinically useful reference point for risk stratification, particularly in elderly patients who require early and accurate identification of severe disease.

In addition to NLR and lymphocyte count, Unal et al. investigated the utility of immature granulocyte parameters in appendicitis diagnosis and severity differentiation.[14] In their study of 438 patients, both the immature granulocyte count (IGC) and percentage (IG%) were significantly associated with acute and complicated appendicitis. Notably, IG% demonstrated excellent diagnostic performance for complicated cases, with an AUC of 0.979, sensitivity of 94.4%, and specificity of 97.9%. In our study, although elevated immature granulocyte values were significantly associated with ICU admission in univariate analysis, they did not retain significance in the multivariate model. This discrepancy may be explained by differences in outcome definitions: while Unal et al. focused on appendiceal perforation, we used ICU admission as a more stringent and clinically relevant endpoint for elderly patients. Despite this, our findings suggest that immature granulocytes may still represent a valuable early marker of disease severity, deserving further investigation in larger and more targeted cohorts.

Overall, the existing literature reinforces the prognostic utility of hematologic parameters—particularly NLR, lymphocyte count, and immature granulocytes—in assessing disease severity in acute appendicitis. Our study adds to this evidence by emphasizing the relevance of these markers in predicting ICU admission among elderly patients, a group at higher risk for adverse outcomes and diagnostic challenges.

Limitations

This study has several limitations that should be acknowledged. First, its retrospective, single-center design may limit the generalizability of the findings to broader populations or different healthcare settings. Variations in clinical protocols, ICU admission criteria, and perioperative management practices could influence the applicability of the results.

Second, the total sample size, and particularly the number of patients requiring ICU admission (n=33), was modest for certain subgroup analyses. This may have limited the ability to detect associations with less frequent variables or outcomes. However, a post hoc power analysis indicated that with this distribution and an assumed moderate effect size (Cohen's d=0.5), the study had approximately 80% power using a two-sided test at an alpha level of 0.05. While sufficient for detecting moderate effects, larger prospective studies are needed to confirm these findings and explore smaller or more nuanced associations.

Third, the analysis was based solely on laboratory parameters

obtained at ED admission, without incorporating dynamic changes over time or postoperative trends. Serial measurements could have provided additional insight into disease progression and response to treatment.

Fourth, although ICU admission decisions were made by anesthesiology specialists according to standardized clinical criteria, some degree of subjectivity and inter-clinician variability in ICU triage decisions is possible, which could introduce bias.

Lastly, other potentially relevant clinical factors, such as frailty status, nutritional state, or the presence of cognitive impairment—which are especially pertinent in geriatric populations—were not included in the analysis due to limitations in available data.

Prospective, multicenter studies with larger cohorts and inclusion of longitudinal biomarker monitoring are warranted to validate these findings and further clarify the role of hematologic parameters in predicting ICU admission in elderly patients with acute appendicitis.

CONCLUSION

In elderly patients with acute appendicitis, early identification of those at risk for ICU admission is critical for timely intervention and optimal resource utilization. Our findings suggest that hematologic parameters—particularly lymphocyte and neutrophil counts—may serve as practical, readily available biomarkers for early risk stratification. Lymphopenia emerged as a significant independent predictor of complicated appendicitis, while neutrophilia was a significant independent predictor of ICU admission. Although the predictive value of IGs did not remain significant in multivariate models, their role warrants further investigation.

This study highlights the potential utility of simple blood-based markers in guiding early clinical decision-making in the ED. Incorporating these parameters into initial assessments may support prompt triage and improve patient outcomes, particularly in vulnerable geriatric populations. Future prospective, multicenter studies with larger cohorts and longitudinal follow-up are needed to validate and refine these findings.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Akut apandisitli yaşlı hastalarda yoğun bakım ünitesine yatış tahmini için regresyon analizi

AMAÇ: Yaşlılarda akut apandisit genellikle atipik semptomlarla ortaya çıkar ve sıklıkla tanıda komplike hale gelir, potansiyel olarak yoğun bakım ünitesine (YBÜ) yatışı gerektirir. Erken risk tanımlaması etkili triyaj için önemlidir. Hematolojik biyobelirteçler hastalığın ciddiyetini tahmin etmek için hızlı ve erişilebilir araçlar sunabilir.

GEREÇ VE YÖNTEM: Yaşlı hastalarda YBÜ'ye yatış ve komplike apandisit için hematolojik parametrelerin (özellikle lenfosit sayısı, nötrofil-lenfosit oranı (NLR) ve immatür granülosit (IG) endeksleri) öngörü değerini değerlendirmek.

Yöntemler: Bu retrospektif gözlemsel çalışmaya 2018-2021 yılları arasında ve 2024'te üçüncü basamak acil serviste şüpheli akut apandisit nedeniyle apendektomi geçiren ≥65 yaş hastaları dahil edildi. Hastalar YBÜ'ye yatış durumuna ve histopatolojik tanıya (komplike ve komplike olmayan apandisit) göre gruplandırıldı. Ameliyat öncesi klinik ve laboratuvar verileri lojistik regresyon ve alıcı işletim karakteristiği (ROC) analizi kullanılarak analiz edildi. Post-hoc güç analizi yapıldı.

BULGULAR: Dahil edilen 143 hastanın 33'ü (%23.1) yoğun bakım ünitesine yatırıldı. Bu hastalar daha yaşlıydı ve daha yüksek diyabet ve koroner arter hastalığı oranlarına sahipti. Yoğun bakım ünitesi grubunda lenfosit sayıları önemli ölçüde düşük ve NLR değerleri daha yüksekti. Çok değişkenli analizde, yalnızca lenfosit sayısı bağımsız olarak yoğun bakım ünitesine yatırılmayı tahmin etti. Komplike apandisit, tek değişkenli analizde yaş, diyabet, düşük lenfosit sayısı, yüksek IG% ve yüksek NLR ile ilişkiliydi; çok değişkenli modellemede yalnızca yaş, diyabet ve lenfosit sayısı anlamlı kaldı. ROC analizi, komplike vakaları belirlemede lenfosit sayısı için orta düzeyde tanı performansı gösterdi (AUC=0.669).

SONUÇ: Lenfopeni, yaşlı hastalarda yoğun bakım ünitesine yatırılmanın ve komplike apandisitin bağımsız bir tahmin edicisidir. Rutin kan parametreleri, acil durumlarda erken klinik risk sınıflandırmasını destekleyebilir.

Anahtar sözcükler: Akut apandisit, yaşlı, yoğun bakım ünitesi, acil servis

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