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RESEARCH ARTICLE

Association of the CALLY Index with Hospital Length of Stay in Acute Pancreatitis

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ABSTRACT

Objective: This prospective single-centre study aimed to investigate the association between the C-reactive protein–albumin–lymphocyte (CALLY) index and hospital length of stay (LOS) in patients with acute pancreatitis (AP), and to assess its concordance with conventional severity scores.

Materials and Methods: A consecutive cohort of 119 AP patients was enrolled. Admission CALLY indices were calculated, and Ranson scores, CT severity index (CTSI) values, and ICU requirement were recorded. Receiver operating characteristic/ area under the curve (AUC) analysis, logistic regression, and negative binomial regression models were applied.

Results: The CALLY index demonstrated moderate discrimination for LOS ≥ 7 days (AUC = 0.64, 95% CI 0.48–0.81), with the optimal cut-off at 0.0082. In logistic regression, lower log(CALLY) was associated with prolonged stay (OR ≈ 0.73, p ≈ 0.04). In negative binomial regression, each 1-log unit decrease in CALLY corresponded to an ~8% increase in LOS (IRR ≈ 0.92, p ≈ 0.03). Conventional severity measures (Ranson, CTSI) and ICU requirement were not significantly associated with LOS.

Conclusion: The CALLY index was independently associated with prolonged hospital stay in AP but not with traditional severity measures, suggesting it may reflect the systemic inflammatory recovery phase. Large multicentre validation studies are warranted.

Keywords: Acute pancreatitis, albumin-lymphocyte ratio, CALLY index, CRP/albumin ratio, hospital length of stay, inflammatory biomarker

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INTRODUCTION

Acute pancreatitis is an inflammatory disease of the pancreas and can range clinically from mild interstitial edema to severe necrotizing forms with multiple organ failure. Among all etiological causes, biliary pancreatitis is reported to be the most common cause, accounting for approximately 35–60% of cases worldwide.[1,2] Although most cases are mild and self-limiting, approximately 15–20% of patients develop a severe form and require intensive treatment.[3] Therefore, predicting the risk of severe acute biliary pancreatitis (ABP) in the early stages is critical for determining the appropriate level of monitoring, fluid therapy, and the timing of endoscopic or surgical intervention.

Different clinical scoring systems have been developed over the past fifty years to determine the severity of the disease and predict mortality. Among these, the Ranson criteria, defined in 1974 and later modified for biliary pancreatitis, have become one of the most widely accepted prognostic tools.[4]

The Ranson score contains biochemical and clinical parameters measured at admission and at 48 hours, thereby enabling objective prediction of disease severity and mortality risk. However, the score's requirement for 48-hour observation limits risk prediction in the early (<24 hours) period and reduces its practicality in emergency unit settings.[5]

In recent years, the role of simple inflammation-based biomarkers in reflecting systemic stress, nutritional status, and immune response has attracted increasing attention. Various studies have demonstrated that composite indicators, such as the C-reactive protein/albumin ratio, neutrophil-to-lymphocyte ratio (NLR), and prognostic nutritional index (PNI),

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can effectively reflect the severity of acute pancreatitis.[6] Among these parameters, the CALLY score is a composite index combining three key biochemical markers—C-reactive protein (CRP), albumin, and lymphocyte count—and was first defined as an indicator of systemic inflammation in oncological and chronic inflammatory diseases.[7,8]

MATERIALS and METHODS

Study Design and Ethical Approval

This prospective observational study was conducted at the General Surgery Clinic of Başakşehir Çam and Sakura, following approval from the local ethics committee (Başakşehir Çam and Sakura Clinical Research Ethics Committee: KAEK-11/12.02.2025.48 approved on 04.03.2025). Written consent was obtained from the patients for participation in the study and for the publication of relevant data. The aim of the study was to evaluate whether the CALLY (CRP–Albumin–Lymphocyte Index) index, previously defined as an inflammatory and prognostic marker in malignant diseases, can also predict the severity of inflammation and prognosis in cases of acute biliary pancreatitis. A total of 119 consecutive patients admitted to the hospital with a diagnosis of acute biliary pancreatitis were prospectively included in the study. The diagnosis was based on the criteria of the Revised Atlanta Classification (2012): characteristic abdominal pain, serum amylase and/or lipase levels at least three times higher than the upper limit of normal, and findings consistent with acute pancreatitis on contrast-enhanced computed tomography. Patients with chronic pancreatitis, pancreatic malignancy, severe liver or renal failure, or incomplete laboratory data were excluded from the study.

Venous blood samples were collected within the first 24 hours of hospitalization for all cases; complete blood count, liver function tests, C-reactive protein (CRP), albumin, and lymphocyte count were performed. The CALLY index was calculated using the following formula:

CALLY = (Albumin (g/dL) × Lymphocyte count (/μL)) / (CRP (mg/dL) × 10)

Demographic data, including age, gender, and body mass index, history of comorbidities, and etiological factors, were recorded for each patient. All intravenous contrast-enhanced abdominal computed tomography scans were done within the first 72 hours of admission, and the images were reviewed using the CT Severity Index. Pancreatic necrosis, peripancreatic fluid collection, and biliary obstruction were noted in the images.

Length of stay in the hospital, intensive care requirements, and development of local or systemic complications such as necrosis, abscess, organ failure, mortality, etc., were recorded for patients. In the initial period of 24 hours of admission, the Ranson criteria for every patient were calculated. The association between the CALLY index and the Ranson score, CTSI, and clinical outcomes was analyzed to investigate the potential value of this index in predicting inflammatory burden and prognosis in acute biliary pancreatitis.

Statistical Analysis

All analyses were performed with the R software version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria). Data on continuous variables are presented as mean ± standard deviation (SD) or median (IQR), whereas categorical data are presented as percentages (%). Comparisons between groups were made by Student's t-test or the Mann–Whitney U test, and for categorical variables, by the Chi-square test or Fisher's exact test. The Spearman correlation analysis was performed to evaluate the relation of the CALLY index with the Ranson score and CTSI. Receiver operating characteristic (ROC) analysis was used to test the discriminatory power of the CALLY index in the prediction of severe disease and/or prolonged hospitalization. In all statistical analyses, the threshold for significance was set at $p<0.05$.

RESULTS

The study included 119 cases of acute pancreatitis. The mean age of participants was 57.1±17.3 years, and 63.9% were female. The mean length of stay (LOS) was 4.5±3.9 days, and the intensive care unit (ICU) requirement rate was 3.4% (n=4). Seventeen cases (14.3%) met the criteria for prolonged hospitalization (LOS ≥7 days). Basic demographic and clinical characteristics are summarized in Table 1.

The CALLY index demonstrated moderate discriminatory power in predicting prolonged hospital stay (LOS ≥7 days) [area under the curve (AUC) = 0.644, 95% Confidence Interval (CI) 0.475–0.812; Fig. 1]. The optimal Youden threshold was determined to be 0.0082; at this point, sensitivity was 58.8%, specificity was 79.4%, positive predictive value (PPV) was 32.3%, and negative predictive value (NPV) was 92.0% (Table 2). When a stricter definition (LOS ≥10 days) was used, the discriminatory power of the CALLY index increased (AUC=0.739, 95% CI 0.521–0.956; Fig. 2), with sensitivity at the same threshold found to be 80.0% and specificity 78.9%.

In the logistic regression analysis, the parsimonious model, including age, gender, and log(CALLY), yielded an OR=0.73 (95% CI 0.53–1.00, p=0.054) for log(CALLY) (AUC=0.68).

Table 1. Demographic and clinical characteristics of the study population

Variable	Mean±SD/n (%)
Age (years)	57.1±17.3
Female sex	76 (63.9)
BMI (kg/m²)	28.4±4.6
Length of stay (LOS, days)	4.5±3.9
Prolonged LOS (≥7 days)	17 (14.3)
ICU requirement	4 (3.4)
Mean CALLY index	0.147±0.31
Mean ranson score	0.97±1.01
Mean CTSI	1.47±1.22

Baseline demographic and clinical variables of the prospective cohort. BMI: Body mass index; ICU: Intensive care unit; CALLY: C-reactive protein–albumin–lymphocyte; CTSI: CT severity index

Table 2. Diagnostic performance metrics of the CALLY index for predicting prolonged LOS (≥7 days)

Metric	Value
AUC (95% CI)	0.644 (0.475–0.812)
Optimal threshold	0.008218
Sensitivity (%)	58.8
Specificity (%)	79.4
PPV (%)	32.3
NPV (%)	92.0

Diagnostic performance of the CALLY index based on Youden's optimal cut-off for predicting prolonged hospital stay. AUC: Area under the curve; PPV: Positive predictive value; Negative predictive value; CALLY: C-reactive protein–albumin–lymphocyte

In the expanded model, which included the variables glucose, urea, and creatinine, the discriminatory power did not change significantly (AUC 0.69 vs. 0.65; DeLong p=0.49). In the additional model comprising gender, BMI, and log(-CALLY), the log(CALLY) value was found to be OR=0.73 (95% CI 0.53–0.98, p=0.039); BMI (p=0.41) and gender (p=0.20) showed no significant association (Table 3). The calibration of the logistic models was adequate (Brier=0.114; Hosmer–Lemeshow p=0.496; calibration slope ≈ 1.00). In the bootstrap internal validation analysis, the apparent AUC value of the model was found to be 0.68, and the optimism-corrected AUC value was 0.57.

Due to the detection of overdispersion in the distribution of the LOS variable (dispersion = 3.48; p=0.006), negative binomial regression analysis was applied. In the parsimonious

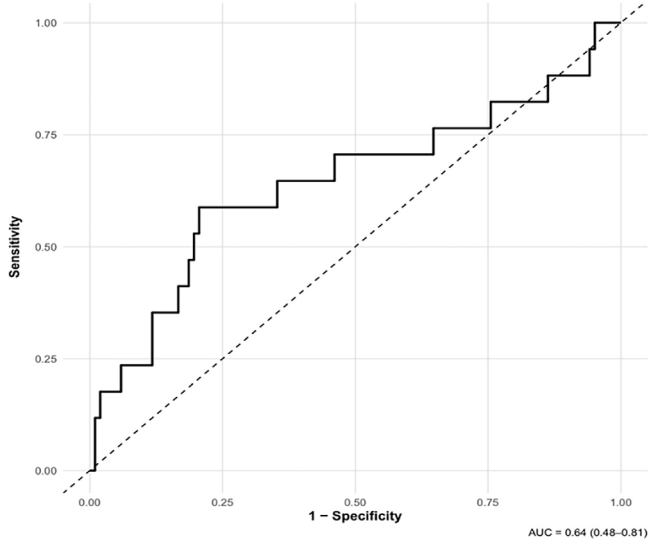


Figure 1. ROC curve of the CALLY index for predicting prolonged hospital stay (LOS ≥ 7 days). ROC curve showing the discriminatory performance of the CALLY index for predicting prolonged hospitalization defined as LOS ≥7 days. The area under the curve (AUC=0.64, 95% CI 0.48–0.81) indicates moderate discrimination

ROC: Receiver operating characteristic; LOS: Length of stay; CALLY: C-reactive protein–albumin–lymphocyte; AUC: Area under the curve; CI: Cardiac index

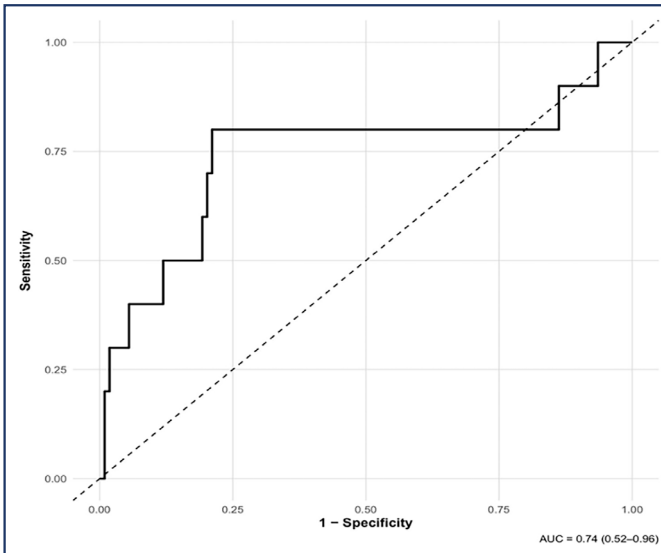


Figure 2. ROC curve of the CALLY index for predicting prolonged hospital stay (LOS ≥ 10 days). ROC curve of the CALLY index for predicting prolonged hospitalization defined as LOS ≥ 10 days. The AUC=0.74 (95% CI 0.52–0.96) demonstrates improved discriminative ability compared with the LOS ≥ 7 threshold

Table 3. Logistic regression model including sex, BMI, and log(CALLY)

Variable	OR	95% CI	p
Female sex	2.23	0.71–8.66	0.199
BMI	1.00	1.00–1.00	0.405
log(CALLY)	0.73	0.53–0.98	0.039

Model performance: AUC =0.68; Brier =0.114; HL p=0.496. Multivariable logistic regression model demonstrating that lower log(CALLY) independently predicts prolonged hospitalization. OR: Odds ratio; CI: Confidence interval; BMI: Body mass index; CALLY: C-reactive protein–albumin–lymphocyte

model (age + sex + log(CALLY)), log (CALLY) yielded IRR=0.92 (95% CI 0.86–0.99, p=0.028). Similar results were observed in the expanded model (+ glucose, urea, creatinine) (IRR=0.92, p=0.032). Adding the log(CALLY) variable significantly improved model fit (LR χ^2=5.2, df = 1, p=0.022; Table 4).

No significant correlation was found between CALLY and classic violence indicators. The CALLY–Ranson correlation was calculated as ρ=-0.06 (p=0.514), and the CALLY–CTSI correlation was calculated as ρ=-0.07 (p=0.476). The ROC analysis for Ranson ≥3 showed AUC = 0.512 (Fig. 3), and no significant distinction was observed in the CTSI ≥4 group (n=2) (Wilcoxon p=0.096). The discriminatory power of the CALLY index in terms of ICU requirement was limited (AUC=0.539; Firth-corrected p=0.395).

Low log(CALLY) values were associated with prolonged hospital stay (LOS) in all models. No significant association was observed with the Ranson score, CTSI, or ICU requirement. Model performance metrics and calibration values are presented in the relevant tables (Table 3,4).

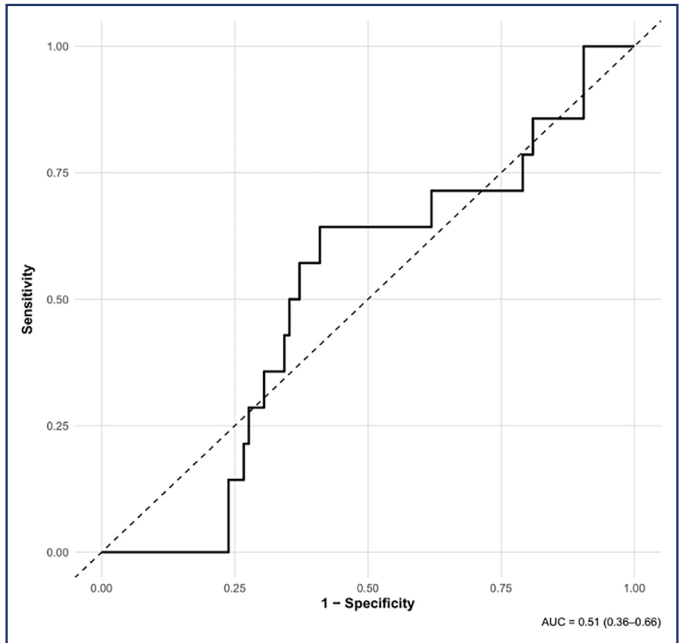


Figure 3. ROC curve of the CALLY index for predicting severe disease (Ranson ≥ 3). ROC curve evaluating the ability of the CALLY index to identify severe acute pancreatitis defined as Ranson score ≥ 3. The AUC=0.51 (95% CI 0.36–0.66) indicates no significant discriminatory power.

ROC: Receiver operating characteristic; CALLY: C-reactive protein–albumin–lymphocyte; AUC: Area under the curve; CI: Cardiac index

DISCUSSION

In this prospective, single-center cohort, the association between the CALLY index and length of stay (LOS) in patients with acute pancreatitis (AP) was evaluated, along with its agreement with traditional severity measures (Ranson score, CT Severity Index [CTSI]). The main finding was that lower CALLY values were consistently associated with more extended hospital stays; in contrast, no significant association was found with Ranson, CTSI, or ICU requirements. These results were consistent with those of the ROC/AUC analyses and logistic and negative binomial (NB) regression analyses.

The CALLY index combines CRP, albumin, and lymphocyte count into a single composite scale (familiar formula: albumin × lymphocytes / [CRP×10]). Each component indicates the burden of inflammation, nutritional status, and immune capacity; therefore, CALLY can be expected to carry a biological signal related to the "systemic inflammatory resolution/recovery tempo." In the literature, CALLY has been studied as a prognostic marker in different populations, primarily hepatocellular carcinoma and other oncological/chronic conditions, and its formula and rationale for use have been detailed.[8–10]

Table 4. Negative binomial regression models for LOS (days)

Model	Variable	IRR	95% CI	p
Parsimonious (LOS ~ age + sex + log(CALLY))	log(CALLY)	0.92	0.86–0.99	0.028
Extended (+ glucose + urea + creatinine)	log(CALLY)	0.92	0.86–0.99	0.032

Negative binomial models indicate that each 1-log unit decrease in CALLY corresponds to approximately an 8% increase in hospital stay. IRR: incidence rate ratio; CI: Confidence interval; LOS: Length of stay; CALL: C-reactive protein–albumin–lymphocyte

The CALLY–LOS relationship observed in AP is consistent with this biological rationale. In our study, the AUC was in the middle range at the ROC level, and the same effect was also confirmed in NB regression via the incidence rate ratio (IRR). CALLY components have also been independently examined in the literature in terms of AP prognosis. Hypoalbuminemia is associated with persistent organ failure and mortality in the early period; CRP is associated with early severity prediction; lymphocyte dynamics/NLR is associated with an unfavorable course. These findings support the idea that the component-based biology of CALLY can be linked to clinical outcomes in AP.[11–13]

However, CALLY was not correlated with the Ranson score and CTSI in our study. There are possible methodological reasons for this. First, the Revised Atlanta Classification (2012) defines AP based on early and late phases, as well as mild, moderately severe, and severe severity categories. A significant portion of the population exhibits mild AP characteristics, and clinical improvement typically occurs within the first week in most cases. The Ranson and image-based CTSI scores, calculated in the early period, reflect the initial severity. At the same time, CALLY may be more related to the duration of inflammatory resolution and, consequently, LOS. Second, the methodological limitations of Ranson (multiple parameters, need for completion within 48 hours, historical development relative to modern intensive care conditions) are well known; CTSI captures a different determinant by scoring anatomical damage and necrosis. This framework explains that CALLY may be a marker sensitive to "recovery speed" rather than "initial severity".[14–16]

In terms of clinical outcomes, the ease with which CALLY can be calculated from routine biochemical data enhances its applicability in the context of cut-off and risk stratification, as well as admission planning. However, Youden cut-off values are cohort-specific; they require recalibration and external validation in different patient mixes and treatment pathways. Given the majority of mild cases in AP and the supportive nature of clinical care, the heterogeneity of biological and organizational factors affecting LOS should also be evaluated.[17]

Limitations include a single-center design, a relatively low number of prolonged LOS events (which constrains the number of events per variable for multivariate modeling), low event frequency in severe disease subgroups (Ranson ≥3, CTSI ≥4, ICU), and a lack of external validation. In contrast, the study's prospective cohort design, sequential case approach, and consistent results from multiple statistical methods, such as ROC–logistic, NB, and internal validation using bootstrap, are strengths. Future studies should aim to validate the CALLY–LOS relationship using multicenter and larger samples, incorporate benefit-focused assessments such as decision-curve analysis, and include incremental value analyses that combine CALLY with scores such as Ranson/BISAP/CTSI.[16] This study shows that the CALLY index does not correlate with baseline severity measures in the ICU; however, lower CALLY values are associated with longer LOS. The findings suggest that CALLY may capture the systemic inflammatory recovery window; external validation and cut-off calibration in application scenarios are required to demonstrate clinical benefit.[10]

CONCLUSION

In this prospective study, no significant correlation was found between the CALLY index and traditional severity measures (Ranson score, CTSI, intensive care requirement) in patients with acute pancreatitis; however, lower CALLY values were shown to be independently associated with more extended hospital stays. Therefore, CALLY may be a promising prognostic marker that can be easily calculated from daily laboratory data; however, multicenter validation studies and calibration of the cut-off value are required before clinical implementation.

Disclosures

Ethics Committee Approval: The study was approved by the Başakşehir Çam and Sakura Clinical Research Ethics Committee (No: 11/12.02.2025.48, Date: 04/03/2025).

Informed Consent: Written consent was obtained from the patients for participation in the study and for the publication of relevant data.

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