Can C-reactive protein levels increase the accuracy of the Ranson score in predicting the severity and prognosis of acute pancreatitis? A prospective cohort study

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ABSTRACT

Background/Aims: Acute pancreatitis (AP) is an acute inflammatory disorder of the pancreas, and its severe form affects nearly all systems of the body. The purpose of this study is to assess the Ranson score and the C-reactive-protein level as a novel model for prediction of the disease severity and mortality.

Materials and Methods: A prospective cohort study was designed to evaluate the efficacy of the C-reactive-protein for the prediction of severe AP. We recorded the Ranson score and C-reactive-protein values in AP patients and determined the severity of the disease using the revised Atlanta classification. Four groups of criteria sets were created: Group 1: Ranson ≥3; Group 2: C-reactive-protein ≥150 mg/L; Group 3: Ranson ≥3 and C-reactive-protein ≥150 mg/L; Group 4: Ranson ≥3 or C-reactive-protein ≥150 mg/L. Identification of AP severity was accepted as the reference parameter for statistical analysis. Categorical variables were expressed as frequencies and percentages. The differences were considered as significant if the p value <0.05.

Results: Six hundred and thirty-eight patients with AP were included in our study. We recovered a statistically significant difference in our assessment of the prediction of the severity of AP among the various groups (p=0.001). Our analysis revealed that group 4 had the highest sensitivity of 90.1% and 93.5% to differentiate moderately severe and severe AP from mild AP, respectively. Group 3 had the highest specificity of 97.1% for both moderately severe and severe AP.

Conclusion: With the use of our new model, C-reactive-protein levels increase the efficacy of the Ranson score for predicting the severity of AP.

Keywords: Acute pancreatitis, severe pancreatitis, prediction

INTRODUCTION

Acute pancreatitis (AP) is a common and serious disease of the pancreas with an increasing incidence over the past two decades (1). The acute inflammatory process in AP differs according to the severity of the disease. The Acute Pancreatitis Classification Working Group reported a 2012 revision of the Atlanta Classification and redefined the severity of AP (2). Severe AP composes approximately 20% of AP cases and is associated with a high mortality rate of roughly 20%. Although treatment regimens are almost universal for mild AP, treatment modalities differ according to local and systemic complications for severe AP (3).

The identification of severe AP using scoring or grading systems is a crucial and complex issue, which is especially critical for predicting the prognosis. Various laboratory tests, scales, and indices, including the Ranson, Glasgow, and Acute Physiology and Chronic Health Evaluation (APACHE) II scores, have been used to predict the severity and mortality of AP (4-6). However, the power of these scoring and grading systems for predicting the morbidity and mortality of AP remains controversial. The Ranson criteria, one of the earliest and most commonly used scoring systems, have been discussed with regard to their low sensitivity and specificity (7,8).

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The C-reactive protein (CRP) is a nonspecific inflammatory mediator, and its production is induced by cytokine stimulation. The CRP test is widely available in laboratories, and various researchers have suggesting using CRP as a prognostic marker for severe AP (9). However, a primary problem is the lack of specificity to predict severe AP at a level not greater than 80% (2,10,11).

Radiological predictors such as computed tomography (CT) have been used frequently in a selective manner, although these imaging techniques depend on the evolution of AP. Due to progressive changes during the follow-up period, imaging findings may not be helpful for detection of local complications, particularly in the early period of the disease. These complications may include pancreatic necrosis, an infrequent event observed after the onset of symptoms (1,12). The most commonly used radiologic scale is Balthazar's CT severity index, which has 90% sensitivity in terms of detection rate after four days for pancreatic necrosis (10). Although imaging techniques alone can be useful for detecting local complications, additional parameters should also be employed to score or grade AP.

In the literature, several scoring systems and prognostic factors, i.e., APACHE-O, have been studied together to ensure that severe clinical courses of AP are diagnosed with a better accuracy (13). However, the most effective combination of these parameters remains to be determined.

Here, we aimed to determine the accuracy of the Ranson score and CRP using a novel model to predict the severity of AP and AP-related mortality.

MATERIALS AND METHODS

We designed a descriptive study (prospective cohort) to evaluate the efficacy of a new model in differentiating the severity of AP.

The study protocol was approved by the local ethical committee (UEARH-2015-8062), and the universal principles of the 1964 Declaration of Helsinki and its later amendments were applied. Written informed consent was obtained from all patients. Patients with all possible causes of AP were included in this study after the patient's approval. Patients were excluded from the study if they were diagnosed with acute cholecystitis or cholangitis before or during the course of the disease. We recorded data such as the patients' demographics, etiologies for AP, and AP-related mortality. A routine medical history and clinical examination were conducted for each patient.

The diagnosis of AP was based on the presence of at least two of the three following features as described in the Atlanta classification criteria 2012 revision: a characteristic clinical history of abdominal pain, a raised serum amylase or lipase concentration (three times the highest normal serum value), and characteristic features detected by CT (2).

We performed abdominal ultrasonography within 24 hours of admission to reveal biliary etiology in all patients. We did not use CT routinely in the emergency room or on admission to the hospital as advised in Atlanta's study; however, we performed a CT selectively in the presence of failure in the diagnosis of AP in a patient with abdominal pain and raised amylase and clinical suspicion about the development of local pancreatic complications within 5-7 days after admission. We evaluated the imaging results with regard to the presence of acute peripancreatic fluid collection, pancreatic necrosis, and pseudocyst formation to determine the local complications of AP (2).

The severity of AP was divided into three entities as described in the Atlanta study. Severe AP is characterized by the presence of organ failure that exceeds 48 hours. Moderate severe AP is defined as the presence of local or systemic complications and/or organ failure that resolves itself within 48 hours (transient organ failure). The remaining AP patients are defined as having mild AP. Three organ systems-respiratory, cardiovascular, and renal-have been assessed to define organ failure using the modified Marshall scoring system (2).

We collected serum samples from the patients at admission and after 48 hours to calculate the Ranson score. A Ranson score of 3 was regarded as the cutoff value to differentiate severe AP from mild (14). We measured the CRP concentration as part of the routine laboratory examination, and the highest reading of the CRP within the first 48 hours above 150 mg/L was regarded as the cutoff value for the identification of severe AP (15). The CRP was calculated using an ELISA kit.

A new system was developed for predicting severe AP using the Ranson score and CRP measurements. A Ranson score of 3 was used as the cutoff level of Group 1, and a CRP value of 150 mg/L was used as the cutoff level of Group 2. Then, integration of both groups resulted in Group 3 as "Ranson and CRP" and Group 4 as "Ranson or CRP." We accordingly created four groups based on the Ranson score and CRP. A schematic view of the groups according to the criteria set is summarized in Figure 1.
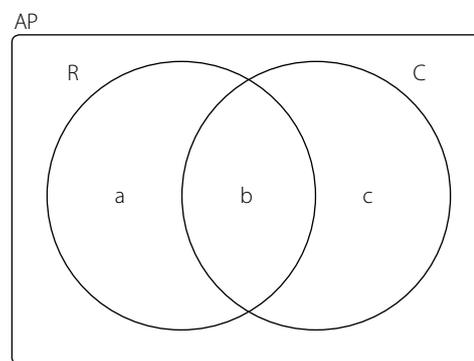
Figure 1. Schematic view of group sets. Upper case letters are used for clusters, lower case letters for areas. AP: Acute Pancreatitis study group, R: Ranson score ≥3, C: CRP value ≥150 mg/L, Group 1: Ranson ≥3 (a+b), Group 2: CRP ≥150 (b+c), Group 3: Ranson ≥3 and CRP ≥150 (b), Group 4: Ranson ≥3 or CRP ≥150 (a+b+c).

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We analyzed the accuracy of the criteria sets of each group to predict severe AP and mortality.

We employed a standard treatment protocol including intravenous fluids, analgesia and prophylaxis for venous thromboembolism. Surgical treatment was applied in the presence of both infected pancreatic necrosis shown by microbiologic analysis and deterioration of organ dysfunction. The clinical course of the patients was followed prospectively until discharge, withdrawal of consent, or death, which allowed the patients to be categorized as having a mild or severe form of the disease.

Statistical Analysis

Identification of AP severity according to the revised Atlanta classification criteria was accepted as the reference parameter. We performed an analysis of the prediction of severe AP and the overall mortality using different criteria sets. The statistical calculations were performed using IBM Statistical Package for the Social Sciences 22 (IBM SPSS, USA) and Power Analysis and Sample Size (PASS) statistical software (Utah, USA). Normally distributed continuous variables were expressed as the mean±standard deviation (SD). The remaining continuous variables were expressed in the median and their interquartile range. Categorical variables were expressed as frequencies and percentages. We used the chi-squared test, Fisher's exact test and the Yates Continuity Correction test to compare continuous parametric variables. We used the Mann-Whitney U test for comparing parametric variables that lacked a normal distribution. We calculated sensitivity, specificity, positive and negative predictive values, and the overall accuracy of the groups of the criteria sets. The statistical results are presented as an odds ratio with a 95% confidence interval (CI). The differences were considered to be statistically significant if the p value was less than 0.05.

RESULTS

Over the course of the study period, we evaluated 650 cases of AP for eligibility. After exclusion of 12 patients, the study group included 638 cases of AP. The flow diagram of the study is shown in Figure 2.

The mean age of the patients was 57.6±18.4 years. The female-to-male ratio was 1.9 (419/219). Gallstones (63.9%) were the most commonly encountered etiology for AP. Hyperlipidemia (16.6%), post-ERCP (12.2%), and idiopathic (5.6%) were other important etiological factors for the development of AP.

After using the revised Atlanta classification criteria, 46 patients (7.2%) were diagnosed as severe AP and 77 patients (12.1%) as moderately severe AP. Organ failure developed in 68 patients (14 of them developed in first 48 hours), and 22 of these cases were transient. Pancreatic local complications detected by imaging techniques and systemic complications were observed in 43 and 12 patients, respectively. The remaining 515 (80.7%) AP patients were diagnosed as mild AP (Figure 2).

There was no relation between the severity of AP and demographic parameters (p=0.071 for gender; p=0.160 for age; Table 1) or the etiology of AP (p=0.470). However, there was a statistically significant relationship between the length of the hospital stay and the severity of AP (p=0.001; Table 1). The subgroup analysis revealed that although the length of the hospital stay of mild AP patients was shorter than that of moderately severe and severe AP patients, there was no difference between the length of the hospital stay of moderately severe and severe AP patients.

The Ranson score and CRP value distributions according to the severity of AP are shown in Table 2, and both scores were significantly higher in the moderately severe and severe AP patients in comparison to the mild AP patients (p=0.001). However, no statistical differences were found between the moderately severe and severe AP patients with regard to the Ranson and CRP values.

We conducted a preliminary statistical analysis of the groups and the severity of the AP. All of the groups' assessments revealed statistically significant differences (p=0.001; Table 3). The subgroup
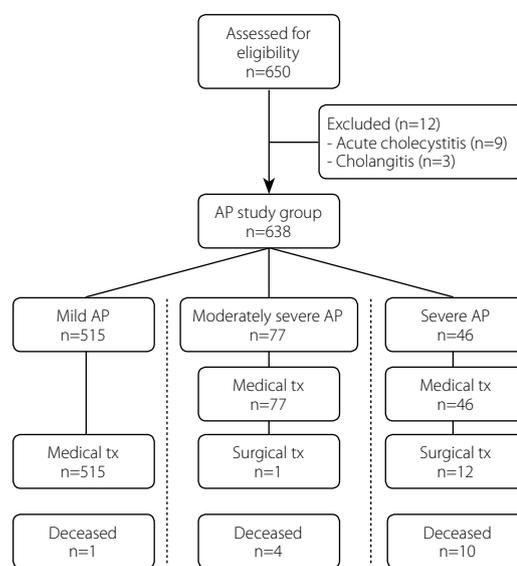
Figure 2. Flow-diagram of the study
AP: acute pancreatitis; tx: treatment

Table 1. Characteristics of acute pancreatitis patients

	Mild AP (n=515)	Moderately severe AP (n=77)	Severe AP (n=46)	p
Female/Male Ratio	349/166 2.1	43/34 1.4	27/19 1.4	0.071[†]
Age Mean±SD	57±18.7	60.7±16.7	60±17.1	0.160[‡]
Length of hospital stay Median (IQR)	7 (5-9)	14 (10-24)	27 (14.5-63)	0.001*, [§]

AP: acute pancreatitis; SD: standard deviation; IQR: interquartile range, [†]Chi-square test, [‡]Anova test, [§]Kruskal Wallis Test, *p<0.05

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analysis demonstrated that these differences were present between mild AP and other severe AP groups (moderately severe and severe) individually. However, no difference was found between moderately severe and severe AP for Groups 1, 2, 3, and 4 (p values of 0.500, 0.297, 0.739, and 0.476, respectively).

After these assessments, two subgroups of severe AP patients, moderately severe and severe, were evaluated individually to measure the groups' accuracies in differentiating mild AP from severe forms of AP (Table 4, 5).

The analysis between moderately severe and mild AP revealed that Group 4 had the highest sensitivity of 90.1% in selection of moderately severe AP, and Group 3 had the highest specificity of 97.1%. The highest overall accuracy was detected in Group 3 as 92.2% in differentiation of moderately severe AP from mild AP. Although there were statistically significant differences in terms of identifying moderately severe AP for all groups (p=0.001 for all), the probability was the highest in Group 3 (odds ratio within 95% CI was 49.5 (24.9-98.3)) (Table 4).

The analysis of severe and mild AP revealed that Group 4 had the highest sensitivity of 93.5% and that Group 3 had the highest specificity of 97.1% in differentiation of severe AP from mild AP. The highest overall accuracy was detected in Group 3 at 94.6% in selection of severe AP. Although there were statistically significant differences in terms of identifying moderately severe AP for all groups, the probability was the highest in Group 3 (odds ratio within 95% CI was 68.9 (30.9-153.7)) (Table 5).

Fifteen patients in total died as a result of AP. Therefore, the mortality rate for AP was 2.4%. One of the deceased patients had been classified as having mild AP, four as moderately severe AP and 10 as severe AP, and the specific mortality rates according to the severity of AP were 0.2%, 5.2%, 21.7% for mild, moderately severe and severe AP, respectively. There was a statistically significant correlation for predicting the mortality for Groups 2, 3, and 4 (p values of 0.001 for each). The statistical ac-

curacy was the highest in Group 3 (86.7%), and the odds ratio was 18.4 within 95% CI (5.7-59.2) (Table 6).

DISCUSSION

Although AP has been recognized for more than a century, predicting the development of severe AP still remains a challenge. Many systems have been used to predict the severity and prognosis of pancreatitis at an early stage, but none

Table 2. Ranson score and CRP value relation with the severity of acute pancreatitis

	Mild AP	Moderately severe AP	Severe AP	
	Median (IQR)	Median (IQR)	Median (IQR)	p'
Ranson score	1 (1-2)	3 (2-4)	3 (2-3)	0.001*
CRP value	55 (24-114)	215 (177-257)	222 (171.3-242.5)	0.001*

AP: acute pancreatitis; IQR: interquartile range; C-reactive protein, †Kruskal Wallis Test, *p<0.01

Table 3. Groups distribution and analysis related to the severity of acute pancreatitis

	Mild AP (n=515)	Moderately severe AP (n=77)	Severe AP (n=46)	
	n (%)	n (%)	n (%)	p†
Group 1 (Ranson ≥3)	47 (9.1)	54 (70.1)	36 (78.3)	0.001*
Group 2 (CRP ≥150)	98 (19)	62 (80.5)	38 (82.6)	0.001*
Group 3 (Ranson ≥3 and CRP ≥150)	15 (2.9)	46 (59.7)	31 (67.4)	0.001*
Group 4 (Ranson ≥3 or CRP ≥150)	130 (25.2)	70 (90.9)	43 (93.5)	0.001*

MP: mild acute pancreatitis; MSP: moderate severe acute pancreatitis; SP: severe acute pancreatitis, †Chi-Square Test, *p<0.05

Table 4. Sensitivity, specificity, negative and positive predictive values and overall accuracy of the criteria sets to detect moderately severe AP

Groups	Moderately severe AP (n=77) n (%)	Mild AP (n=515) n (%)	p†	Odds ratio (CI 95%)	SEN %	SPE %	PPV %	NPV %	ACC %
Group 1 (Ranson ≥3)	54 (70.1)	47 (9.1)	0.001*	23.4 (13.2-41.5)	70.1	90.9	53.5	95.3	88.2
Group 2 (CRP ≥150)	62 (80.5)	98 (19)	0.001*	17.6 (9.6-32.2)	80.5	80.9	38.7	96.5	80.1
Group 3 (Ranson ≥3 and CRP ≥150)	46 (59.7)	15 (2.9)	0.001*	49.5 (24.9-98.3)	59.7	97.1	75.4	94.2	92.2
Group 4 (Ranson ≥3 or CRP ≥150)	70 (90.9)	130 (25.2)	0.001*	29.6 (13.3-66.1)	90.1	74.8	35.0	98.2	76.8

†Fisher's Exact Test, *p<0.05, AP: acute pancreatitis; SEN: sensitivity; SPE: specificity; PPV: positive predictive value; NPV: negative predictive value; ACC: accuracy

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Table 5. Sensitivity, specificity, negative and positive predictive values and overall accuracy of the criteria sets to detect severe AP

Groups	Severe AP (n=46) n (%)	Mild AP (n=515) n (%)	p†	Odds ratio (CI 95%)	SEN %	SPE %	PPV %	NPV %	ACC %
Group 1 (Ranson ≥3)	36 (78.3)	47 (9.1)	0.001*	35.8 (16.7-76.8)	78.2	90.9	43.4	97.9	89.8
Group 2 (CRP ≥150)	38 (82.6)	98 (19)	0.001*	20.2 (9.1-44.7)	82.6	80.9	27.9	98.1	81.1
Group 3 (Ranson ≥3 and CRP ≥150)	31 (67.4)	15 (2.9)	0.001*	68.9 (30.9-153.7)	67.4	97.1	67.4	97.1	94.6
Group 4 (Ranson ≥3 or CRP ≥150)	43 (93.5)	130 (25.2)	0.001*	42.5 (12.9-139.2)	93.5	74.8	24.9	99.2	76.2

†Fisher's Exact Test, *p<0.05, AP: acute pancreatitis; SEN: sensitivity; SPE: specificity; PPV: positive predictive value; NPV: negative predictive value; ACC: accuracy

Table 6. Association between mortality and study groups

Groups	Deceased (n=15) n (%)	Alive (n=623) n (%)	p†	Odds ratio (CI 95%)	SEN %	SPE %	PPV %	NPV %	ACC %
Group 1 (Ranson ≥3)	12 (80)	125 (20.1)	0.001*	15.9 (4.4-57.3)	80.0	79.9	8.7	99.4	79.9
Group 2 (CRP ≥150)	13 (86.7)	185 (29.7)	0.001*	15.4 (3.4-68.9)	86.7	70.3	6.6	99.5	70.7
Group 3 (Ranson ≥3 and CRP ≥150)	11 (73.3)	81 (13)	0.001*	18.4 (5.7-59.2)	73.3	87.0	11.9	99.3	86.7
Group 4 (Ranson ≥3 or CRP ≥150)	14 (93.3)	229 (36.8)	0.001*	24.1 (3.1-184.5)	93.3	63.2	5.7	99.7	63.9

†Fisher's Exact Test, *p<0.05, AP: acute pancreatitis; SEN: sensitivity; SPE: specificity; PPV: positive predictive value; NPV: negative predictive value; ACC: accuracy

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of these systems has been proven to be perfect (16). Various models have been defined based on clinical, laboratory and radiological findings. Some clinical predictors have been reviewed for severity prediction. An older age (especially older than 75 years), obesity with a body mass index over 30 kg/m^2 and alcoholic pancreatitis have been shown to be predictors of a poorer prognosis (17,18). Clinical judgment of an experienced physician for prediction was used in some reports, which had a sensitivity and specificity of 39% and 93%, respectively (15). Organ failure was used as an assessment criterion of the severity and mortality for severe AP in the 2012 Atlanta revision (2,19). In our study, we used the modified Marshall scoring system for detection of organ failure to identify severe AP patients as described in the Atlanta report (2). We used the Ranson score system and CRP to evaluate the severity of AP. This evaluation ended in 48 hours, and we had evidence of organ failure in 14 patients (20.5% of all organ failure patients) at the point of completion of the predictive test (in 48 hours). With our new model, we were able to differentiate severe AP from mild AP with a sensitivity of 93.5% in group 4 (Ranson ≥3 or C-reactive-protein ≥150 mg/L), and with a specificity of 97.1% in group 3 (Ranson ≥3 and C-reactive-protein ≥150 mg/L).

Another suggested prediction method is the use of laboratory modalities. Hemoconcentration and a high hematocrit level as predictors of severity have been studied and yielded variable results (20). Various serum markers have been studied to predict the severity of AP, including blood urea nitrogen, serum creatinine, serum glucose, serum calcium, amylase, and lipase (21). Some of these markers have been used in scoring systems. These systems have been developed after the analysis of the AP patients' data and are primarily composed of clinical, laboratory and radiologic predictors.

Many scoring systems have been proposed to predict severity, but none has been proven to assess the severity of AP perfectly. Common scoring systems include Ranson, Glasgow, the APACHE II, and BISAP (bedside index for severity in AP) (7,14,22,23). The Ranson score is one of the best-known scoring systems for grading the severity of AP. Although the system continues to be used widely, a meta-analysis of 110 studies found that the Ranson score was a poor predictor of AP severity. A Ranson score of 3 or more changes the sensitivity of the severe AP prediction from 34% to 78% (24). In our study, we first assessed the relationship between the Ranson criteria and the severity of AP based on three types of AP (mild, mod-

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erately severe, severe), and we found statistically significant differences in terms of predicting the severe forms. Then, we evaluated two types of severe AP to calculate the sensitivity of the groups in predicting the severity of AP. After analyzing the Ranson criteria in terms of moderately severe AP prediction, we found that the sensitivity, specificity and accuracy of the Ranson criteria were 70.1%, 90.9%, and 88.2%, respectively. For severe AP prediction from mild AP, the sensitivity, specificity, and accuracy of the Ranson criteria were 78.2%, 90.9%, and 89.8, respectively.

As a rapid acute phase reactant, procalcitonin has been studied for predicting AP severity, and it has been reported that its accuracy is between 77% and 86%. The scarce availability of this test in laboratories is the main problem associated with this method (25,26). Another important acute phase reactant is CRP, and it has been studied in the literature for this aim. It is inexpensive and readily available in most laboratories. A CRP level above 150 mg/L at 48 hours has a sensitivity and specificity of 80% and 76%, respectively, for predicting severe AP (15). A CRP cutoff level of 82 mg/L was studied in a Korean study, and the sensitivity, specificity and accuracy of CRP were reported to be 68.4%, 68%, and 68.2%, respectively (25). In our study, 150 mg/L was used as a CRP cutoff value. We found that the sensitivity, specificity and accuracy of CRP in differentiating moderately severe AP from mild AP were 80.5%, 80.9%, and 80.1%, respectively. In differentiating severe AP from mild AP, the sensitivity, specificity, and accuracy of CRP were 82.9%, 80.9%, and 81.1%, respectively. These values seem to be higher than studies aforementioned. This difference can be caused by various selections of the severity of AP in the studies. We have to mention that the CRP evaluation was more accurate for moderately severe AP than severe AP.

Chest radiography can be used to assess pleural effusion and pulmonary infiltrates associated with necrosis and organ failure. A CT is the most frequently used radiological investigation to evaluate AP and detect necrosis. Intravenous contrast-enhanced CT distinguishes pancreatic necrosis with an accuracy of 90% (11). Several CT scoring systems have been reported as being better than other systems for predicting the severity of AP. Bollen et al. (27) reported no statistically significant differences between the predictive accuracies of CT and clinical scoring systems. In conclusion, these authors did not recommend a CT for conducting a severity assessment. Imaging techniques are recommended when there is a suspicion of local complications, such as pancreatic necrosis (2). In our study, pancreatic local complications detected in CT were used to make a severe AP diagnosis.

The scoring systems for predicting severe AP have been reported in the literature. However, every scoring system or marker has a specific inadequacy, such as its complexity, difficulties in application or low accuracy. Therefore, we aimed to design a combined system of the Ranson score and CRP value to assess AP severity

in order to increase the accuracy. In our study, Group 3 exhibited the best accuracy and specificity in differentiating moderately severe and severe AP from mild AP (92.2% and 94.6%, respectively). However, our efforts were insignificant in Group 4 in differentiating moderately severe and severe AP from mild AP with an accuracy of only 77.8% and 76.2%, respectively.

However, this group yielded the best sensitivity of all groups in differentiating moderately severe and severe AP from mild AP (90.1% and 93.5%). The ability of a test to correctly classify an individual as disease free is known as the test's specificity. Consequently, any test with a specificity of 95% misses only 5% of disease-free patients, and this ratio is acceptable for severe AP. Patients in Group 3 (Ranson ≥3 and CRP ≥150 mg/L) were characterized with a specificity of 97.1% in differentiating both moderately severe and severe AP from mild AP, individually; only 2.9% of moderately severe or severe AP patients were missed.

Predicting the mortality in AP is another challenging situation. Despite advancements in many scoring systems, no single system is a reliable method for predicting mortality. For this evaluation, a scoring system such as APACHE II can be used at regular intervals for AP patients, but imaging assessments may be required as well (28). Ranson et al. (29) reported an increased risk of mortality with an increased number of prognostic signs: 25% mortality was reported with >4 prognostic signs. In our study, we predicted mortality in AP patients as a function of their group. Group 4 resulted in a statistically significant mortality prediction with an odds ratio, positive predictive value and negative predictive value of 24.1 (CI 95%, 3.1-184.5), 5.7% and 99.7%, respectively. Group 3, the patients in which we employed both the Ranson score and CRP, exhibited the best accuracy for mortality evaluation (86.7%). The positive and negative predictive values were 11.9% and 99.3%, respectively. Accordingly, 11.9% of patients with a Ranson score of 3 or more and a CRP value of 150 mg/L or more died. After analysis of the new model, we recommended that the patients should be sent to an intensive care unit if they had high risk of developing severe AP.

The study has a number of possible limitations. CRP itself is a nonspecific inflammation marker, therefore, we excluded the patients with cholangitis and cholecystitis because those might be the reason for the elevated CRP. However, we included patients with post-ERCP pancreatitis. Although they constitute a small portion of the study patients and the ERCP of these patients was performed for choledocholithiasis, there may be some level of undetected or overlooked cholangitis. Besides, inflammation of the biliary system or cholangitis may be present silently in other pancreatitis, e.g., gallstone pancreatitis, to some extent. Future larger studies to reveal this issue would be of interest. Another limitation of the study was that it takes 48 hours to calculate this novel model. We detected only 20.5% of all organ failure patients within 48 hours by classic methods. However, this model can be calculated within 48 hours,

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and it can predict the outcome with over 90% sensitivity and specificity. Nevertheless, further studies have to be designed to overcome this limitation.

In conclusion, predicting the severity and mortality of AP is challenging. Our results show that CRP can increase the efficacy of the Ranson score for predicting the severity of AP. The success of CRP is also reflected in the mortality prediction.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Umraniye Training and Research Hospital (2015-8062). This study is registered with the Research Registry and the unique identifying number is: researchregistry1623.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

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