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CLINICAL STUDY

Acute pancreatitis – predicting the severity of the disease

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ABSTRACT

RATIONALE: Acute pancreatitis (AP) is a serious acute abdominal disease. AP is often referred to as an unpredictable illness, which can take a mild to severe (fatal) course.

AIMS OF THE STUDY: 1) To identify clinical parameters that are significantly related to the clinical course of acute pancreatitis. 2) To compile a scoring system enabling the severity of AP to be predicted when the patient is first admitted to hospital.

METHODS: Analysis of available publications and clinical guidance, and retrospective analysis of data on patients hospitalised with AP at our clinic enable us to identify clinical details and laboratory results recorded at the time of patients' admission to hospital that are related to the subsequent severity of the disease. For the purposes of statistical analysis, the sample of patients was divided into two groups: group A (mild AP, without local or organ complications), group B (moderately severe and severe AP with local and/or organ complications).

PATIENT GROUPS AND RESULTS: In total, between 01.01.2013 and 30.06.2022, 312 patients with acute pancreatitis were allocated to the retrospective-prospective study sample. 74 % (231/312) of these patients were allocated to group A and 26 % (81/312) were allocated to group B. Univariate analysis of the data collected on the patient sample identified 5 parameters that are statistically significantly associated with the severity of the clinical course of the disease. Presence of SIRS on admission (A vs B, Odds ratio 10.787, 95% CI 5.09-22.85, p < 0.0001), diabetes mellitus type 2 in case history (A vs B, Odds ratio 7.703, 95% CI 3.04-19.51, p < 0.0001), hypocalcaemia on admission (A vs B, Odds ratio 8.288, 95% CI 3.84-17.88, p < 0.0001), urea concentration > 8 mmol/l (A vs B, Odds ratio 4.227, 95% CI 1.79-10.00, p = 0.0010) and venous lactate concentration > 2 mmol/l (A vs B, Odds ratio 3.293, 95% CI 1.59-6.82, p = 0.0013).

In order to develop a scoring system, each of these parameters was allocated a points value based on its Odds ratio (OR): presence of SIRS 3 points, hypocalcaemia 3 points, diabetes mellitus type 2 in case history 2 points, urea concentration > 8 mmol/l 1 point and lactate concentration > 2 mmol/l 1 point.

The authors refer to their scoring system as The Acute Pancreatitis Admission Score (APAS). The accuracy of APAS was modelled for various cut off values.

Across the whole sample, we ascertained that an APAS ≥ 4 points predicts moderately severe or severe AP with a sensitivity of 81 % (95% CI: 71 – 89 %) and specificity of 87 % (95 CI: 81 – 91 %). The positive predictive value (PPV) of APAS ≥ 4 is 0.68, while its negative predictive value (NPV) is 0.93 and accuracy 0.85 (95% CI 0.81 – 0.89).

CONCLUSION: In this study we identify significant simple clinical and laboratory parameters that are commonly tested as part of an initial examination when admitting a patient with AP to hospital. Having identified these parameters we are able to establish a simple scoring system that is able to predict the severity of the course of AP at the moment of hospitalisation *(Tab. 5, Fig. 2, Ref. 27)*. Text in PDF *www.elis.sk*

KEY WORDS: acute pancreatitis, prediction score, organ failure, necrosis.

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Introduction

Acute pancreatitis (AP) is an acute inflammation of the pancreas, which is characterized by the activation of pancreatic enzymes to cause self-digestion of the pancreas. It is an acute inflammatory process presenting as a mild- local inflammation to severe disease with single or multiple-organ failure. The internationally recognised Atlanta Classification distinguishes between mild, moderately severe and severe AP according to local and organ complications (Tab. 1). Studies and meta-analyses cite hospital mortality among patients with acute pancreatitis in the range 2–8 %, while in severe cases of AP, this rises to around 30–50 % (1, 2, 3).

Biliary concrements and alcohol are the most frequent cause of acute pancreatitis worldwide. Other causes are infrequent, such as: ERCP, hypercalcaemia, hyperlipidaemia, drug-induced pancreatitis, trauma or tumours. In 5–10 % of cases, the cause of the disease remains unclear (1).

In more than 80 % of cases, pancreatitis takes an acute, mild course and patients do not require any specific treatment or monitoring besides IV hydration and analgesics. Approximately 20 % of patients are at risk of developing local or systemic complications. Numerous scientific studies have considered how to predict the severity of the course of AP, and several scoring systems have been developed (1, 4, 5).

Tab. 1. Atlanta classification of acute pancreatitis, revision 2012.

Atlanta 2012	Mild AP	Moderate AP	Severe AP
Organ failure	No	No or reversible < 48 hours	Yes, persistant > 48 hours
Local complications	No	Yes	

Tab. 2. Descriptive statistics: possible predictive parameters for severity of AP.

Parameter	Patients in group A (n, %)	Patients in group B (n, %)	p
Age > 60 years	102/146 (69.9 %)	44/146 (30.1 %)	0.1146
Repeat episode of AP	44/63 (69.8 %)	19/63 (30.2 %)	0.3950
Pain > 24 hours	77/117 (65.8 %)	40/117 (34.2 %)	0.0102
BMI > 30	72/105 (68.6 %)	33/105 (31.4 %)	0.1167
SIRS +	27/74 (36.5 %)	47/74 (63.5 %)	<0.0001
DM type 2 +	18/45 (40 %)	27/45 (60%)	0.000017
Leucocytosis > $12x10^9$/l	69/171 (40.4 %)	102/171 (59.6 %)	0.0001
Lactate> 2 mmol/l	37/87 (42.5 %)	50/87 (57.5 %)	0.0003
Hypocalcaemia	74/134 (55.2 %)	60/134 (44.8 %)	<0.0001
Urea> 8 mmol/l	29/56 (51.8 %)	27/56 (48.2%)	0.0002

Worldwide, several scoring systems are commonly used for AP. The first of these were the Ranson criteria (1977), which can be used to evaluate biliary and non-biliary forms of pancreatitis. The Glasgow scoring system (1984) is also based on objective clinical indicators; assessment for this purpose is to be completed no later than 48 hours after admission to hospital. The Acute Physiology and Chronic Health Evaluation (APACHE) II was originally developed for critical patients in intensive care, nd was first used for the evaluation of AP in 1989. Most recently, the Bedside Index of Severity in Acute Pancreatitis (BISAP) was proposed in 2008 (6, 7, 8, 9).

In recent years, a large number of papers have been published that compare the accuracy of these various scoring systems. Li et al. found that the Ranson score was less useful for elderly patients (> 60 years) than for younger patients. Despite this, the Ranson score was found to perform better than the three other scoring systems in predicting pancreatic necrosis in elderly patients. The Glasgow system had a similar predictive ability to that of the Ranson score. According to Li et al. Mikó et al, APACHE II is the most accurate system for predicting mortality among elderly patients. For APACHE II, a score ≥ 8 is generally accepted as the criterion for diagnosis of severe AP (SAP). BISAP is a simpler scoring system that has been found to be useful for both elderly and younger patients, although the criterion for predicting SAP differs for these two groups: BISAP ≥ 3 for elderly patients, BISAP ≥ 2 for younger patients (4, 10, 11).

In their study of patients with AP (n = 164), Venkatesh et al. reported that the APACHE II score was able to predict SAP in 52 cases (50 %), the BISAP score in 27 cases (26 %), the Glasgow score in 79 cases (76 %), the Ranson score at admission in 34 cases (33 %), and the Ranson score 48 hours after admission in 61 cases (59 %) when using the prediction criteria cited in the literature (6).

Hagjer et al. evaluated the BISAP score on a sample of 60 patients with acute pancreatitis and found that it predicts severity, organ failure and death very well. Specifically, its predictive performance was comparable to that of the APACHE-II score and outperformed both the Ranson criteria and the CT severity index (14).

Further scoring systems have been proposed in local professional journals but have not yet entered regular clinical use internationally. These include the Chinese Simple Scoring System, Pancreatic Activity Scoring System, PANC3 score and Harmless Acute Pancreatitis Score (15, 16, 17, 18). In recent years, a number of studies have been published that identify additional laboratory parameters whose values may be capable of predicting the severity of acute pancreatitis, such as D-dimer and the NRL ratio (19, 20, 21).

Methods

By analysing the recent literature, existing scoring systems and guidance from gastroenterological associations and through a retrospective analysis of data relating to patients hospitalised with acute pancreatitis at the Department of Internal Medicine at the 1st Faculty of Medicine, Charles University and Military University Hospital in Prague, we identified clinical details and laboratory results recorded at the time of the patient's admission that were related to the subsequent severity of the patient's disease. The data for our retrospective-prospective analysis were collected from patients who were admitted to the Department of Internal Medicine between 01.01.2013 and 30.06.2022.

At the time of admission to hospital, the following clinical details were recorded based on the patient's medical history (or available documentation): age, sex, duration of abdominal pain at the time of the patient's arrival at the hospital's central admissions unit, presence of systemic inflammatory response (SIRS) on examination at admission, body mass index (BMI), presence of serious comorbidities (diabetes mellitus type 2, chronic kidney disease, COPD, cardiac failure or oncological disease) and number of documented episodes of acute pancreatitis in the case history. The laboratory results recorded on admission to hospital were leu-

Tab. 3. Identified risk factors in AP.

	Odds ratio	lower 95% CI	upper 95% CI	p	Number of APAS points
SIRS	10.787700	5.092483	22.852200	0.000000	3
Lactate > 2 mmol/l	3.293420	1.590967	6.817630	0.001324	1
Calcium < 2.1 mmol/l	8.288000	3.842077	17.878580	0.000000	3
Urea > 8 mmol/l	4.227480	1.786540	10.003480	0.001037	1
DM type 2 history	7.703140	3.041638	19.508690	0.000017	2

kocyte count, haematocrit, serum urea concentration, glycaemia, lactate concentration in venous blood, and calcaemia.

The patients were diagnosed and treated in accordance with the valid professional recommendations of the American Gastroenterological Society (22). Observation of each patient was terminated at the time of their transfer or discharge from hospital. We define the severity of the disease in each patient as mild, moderate or severe according to the revised Atlanta Scale, based on the presence or absence of local complications and organ failure, as shown in Table 1 (23).

For the purposes of statistical analysis, the sample of patients was divided into two groups, namely group A (mild AP, without local or organ complications) and group B (moderately severe or severe AP with local and/or organ complications).

Univariate analysis of the data collected on the patient sample enabled us to identify the 5 parameters that are statistically most significantly associated with the severity of the clinical course of the disease in our sample's two patient groups, A and B. These parameters were further subjected to multivariate analysis and on the basis of the resulting odds ratio, we assigned points to each of these parameters on a scale of 1–3: 3 points for the presence of SIRS, 3 points for hypocalcaemia, 2 points in case type 2 diabetes mellitus in patient history, 1 point for urea concentration > 8 mmol/l, 1 point for lactate concentration > 2 mmol/l (Tabs 2 and 3).

On the basis of these parameters and point weighting we have developed a scoring system, which we refer to as APAS, with a total scoring range of 0–10 points. We have modelled the accuracy of the APAS scoring system for various cut-off values and found that the criterion of ASAP ≥ 4 points is statistically most successful in predicting that a patient will be allocated to group B, i.e, have moderately severe or severe AP.

The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki. Written informed consent (approved by the Institutional Ethics Committee) was obtained from each patient in the study.

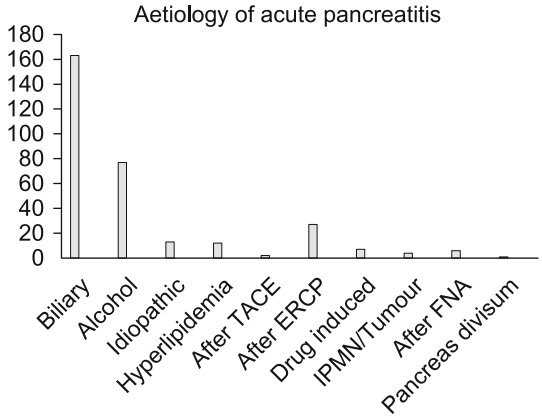

Fig. 1. Aetiology of AP in our sample of 312 patients.

Statistical analysis

Comparisons of continuous variables were made using t-tests or Mann-Whitney tests as appropriate. Comparisons of categorical variables were performed using chi-square tests or Fischer tests as appropriate. Following the univariate analysis, predictors with $p < 0.15$ entered a multivariate logistic regression model which was built using the best subset method. ROC analysis was performed to assess Binary classification. In all cases a p-value of less than 0.05 was considered significant. All computations were performed using STATISTICA 14.0 and Origin 2015 software.

Patient groups and results

312 patients with AP were admitted to the Department of Internal Medicine at the 1st Faculty of Medicine, Charles University and Military University Hospital in Prague between 01.01.2013 and 30.06.2022.

The sample included 177 male and 135 female patients, and the average age among all patients in the sample was 58 years. 231 patients were allocated to group A (mild AP) and 81 to group B (moderately severe or severe AP). The most frequent causes of acute pancreatitis in our sample were biliary (52 % 162/312) or alcoholic (25 %; 78/312) (Fig. 1).

In our sample, 74 % (231/312) of cases of AP took a mild course, without local or organ complications, while 16.4 % (51/312) of patients developed local complications or reversible organ failure, and were therefore discharged with the diagnosis of moderately severe AP. Persistent organ failure lasting more than 48 hours occurred in 9.6 % (30/312) of cases in our sample; these cases met the classification criteria for the diagnosis of severe acute pancreatitis. There were 14 patients who succumbed to organ failure while hospitalised, i.e, the hospital mortality within our sample constituted 4.5 % (14/312). The average duration of hospitalisation with acute pancreatitis was 10.8 days.

Clinical parameters investigated as having a potential relationship with AP severity

Age above 60 years

In our sample, 146 patients were above the age of 60 years and 166 patients were below the age of 60 years at the time of admission to hospital. Among those aged > 60 years, 69.9 % (102/146)

experienced mild AP and were allocated to group A for the purposes of our analysis, while 30.1 % (44/146) experienced moderately severe or severe AP and were allocated to group B. Among the patients aged < 60 years, 77.7 % (129/166) of patients were allocated to group A and 22.3 % (37/166) to group B. Age above 60 years was not a statistically significant risk factor for moderately severe or severe AP in our sample (p = 0.1146).

Number of documented episodes of AP

Our data set included information on the number of documented episodes of AP in each patient's history. For the final evaluation of our sample we divided the patients into two groups: those who were hospitalised with their first episode of AP and those who had experienced more than one episode. The reason for this division is that very few patients in our sample had experienced multiple episodes of AP. Particularly, 249 patients in our sample were admitted with their first episode of AP, while 63 patients were admitted with a repeat episode. Among those for whom this was the first episode of AP, 75.1 % (187/249) of patients were allocated to group A and 24.9 % (62/249) to group B. Among those suffering repeat episodes, 69.8 % (44/63) were allocated to group A and 30.2 % (19/63) to group B. In our sample, patients who were admitted with their first episode of AP had a slightly higher likelihood of mild AP, but this difference was not statistically significant (p = 0.3950) and may have been affected by the substantial difference in the numbers of patients in these two subgroups.

Duration of abdominal pain prior to hospital admission

At the time of the patients' admission to hospital, the duration of their abdominal pain was recorded in hours, from its onset until the time of the initial examination at the emergency unit and commencement of basic treatment (analgesics and intravenous crystalloid rehydration). For the purpose of our analysis, we divided the patients into two groups: 195 patients whose pain had lasted less than 24 hours prior to admission and 117 patients whose pain had lasted more than 24 hours. In the group with pain duration > 24 hours, 65.8 % (77/117) of patients were allocated to group A and 34.2 % (40/117) to group B. In the group with pain duration < 24 hours, 79 % (154/195) of patients were allocated to group A and 21 % (41/195) to group B. In our sample, a longer duration of the core symptom of AP, which is abdominal pain, was associated with a greater risk of moderately severe or severe AP (p = 0.0102). This correlation suggests that delayed commencement of treatment contributes to an increased risk of developing more severe forms of acute pancreatitis.

Obesity with BMI > 30

At the time of admission to hospital, the patients' BMI value was recorded and for the purposes of our analysis we divided the patients into two groups: 105 patients in our sample had a BMI > 30, while 207 had a BMI < 30. In the group of patients with BMI > 30, the probability of being allocated to group B was 31.4 % (33/105), compared with 23.2 % (48/207) of patients with BMI < 30. There were 76.8 % (159/207) of patients with BMI < 30 who experienced mild AP (group A) compared to 68.6 % (72/105) of patients with BMI > 30. Obesity, measured as a BMI higher than 30, was not identified in our sample as a significant risk factor for moderately severe or severe AP (p = 0.1167).

Presence of signs of systemic inflammatory response (SIRS)

During the initial clinical examination carried out at the emergency admissions unit, a note was kept on the presence of any clinical or laboratory signs of SIRS. In our sample, 74 patients showed signs of SIRS, and 238 patients did not. In the set of patients without any signs of SIRS, AP took a mild course (group A) in 85.7 % (204/238) of cases, while 14.3 % (34/238) of these patients were assigned to group B. In the set of patients who showed signs of SIRS during clinical examination at the time of admission to hospital, 36.5 % (27/74) were assigned to group A and 63.5 % (47/74) to group B. The presence of signs of SIRS at the initial examination was confirmed in our sample as a statistically very significant predictive factor for the severity of the disease (p < 0.0001, OR 10.787).

Diabetes mellitus type 2

Our sample included 45 diabetic patients (whose average age was 65.5 years) and 267 non-diabetic patients (average age 57 years). There were 40 % (18/45) of the diabetic patients allocated to group A and 60 % (27/45) to group B, while 79.8 % (213/267) of the non-diabetic patients were allocated to group A and 20.2 % (54/267) to group B. Diabetes mellitus type 2 in the patient's medical history was identified as a statistically significant predictive factor for the severity of AP (p= 0.000017, OR 7.703). In our sample, acute stress hyperglycaemia with initial glycaemia > 8 mmol/l in non-diabetic patients was also recorded as an indicator of risk. This observation at the initial examination raised the risk of moderately severe or severe AP (group B) among non-diabetics to 32.9 % (24/73) compared with 15.5 % (30/194) among non-diabetics whose initial glycaemia was < 8 mmol/l (p = 0.0016). Nevertheless, of these two factors, the presence of diabetes as a comorbidity was more statistically significant.

Laboratory parameters possibly related to AP course

Leucocytosis > $12x10^9$/l

The leucocyte count in peripheral blood was recorded at the initial examination and statistically processed. According to the criteria for SIRS, we set the cut-off value at $12x10^9$/l. Out of 312 patients, there were 171 who had leukocyte counts that exceeded this threshold. Of these, 40.4 % (69/171) were allocated to group A and 59.6 % (102/171) to group B. Among the patients who had leucocyte counts < $12x10^9$/l on admission, 91.5 % (129/141) had mild AP (group A) and 8.5 % (12/141) had moderately severe or severe course of AP (group B) of patients. Leucocytosis > $12x10^9$/l was thus confirmed in our sample as a significant predictive factor for moderately severe or severe AP (p = 0.0001).

Serum concentration of venous lactate > 2 mmol/l

The initial blood tests also measured the serum concentration of venous lactate; a concentration of > 2 mmol/l was identified in

87 out of 312 patients. Of these, 42.5 % (37/87) were allocated to group A and 57.5 % (50/87) to group B. Among the remaining patients, whose concentration of venous lactate was normal, i.e, < 2 mmol/l, 80.4 % (181/225) were allocated to group A and 19.6 % (44/225) to group B. The serum concentration of venous lactate > 2 mmol/l on admission to hospital was thus confirmed in our sample as a significant predictive factor for the severity of AP (p = 0.0003, OR 3.293).

Hypocalcaemia.

During the initial examination, all patients were tested either for their overall serum concentration of calcium (upper limit of normal range, ULN 2.1 mmol/l) or for ionized calcium in POCT analysis (upper limit of normal range, ULN 1.15 mmol/l). Based on these tests, initial hypocalcaemia was diagnosed in 134 patients, of whom 55.2 % (74/134) went on to have a mild course of AP (group A) and 44.8 % (60/134) a moderately severe or severe course (group B). In the set of patients with normal concentrations of serum calcium at initial examination, AP was mild (group A) in 88.2 % (157/178) of cases and moderately severe or severe (group B) in 11.8 % (21/178) of cases. In our sample, the initial hypocalcaemia was thus found to be an important predictive factor for the severity of AP (p < 0.0001, OR 8.288).

Serum urea concentration > 8 mmol/l

Patients' initial serum urea concentration was recorded, and the cut-off was established at 8 mmol/l. There were 56 of 312 patients with serum urea concentration higher than this cut-off; of those, 51.8 % (29/56) were allocated to group A and 48.2 % (27/56) to group B. Among the patients with initial serum urea concentration < 8 mmol/l, 78.9 % (202/256) were allocated to group A and 21.1 % (54/256) to group B. Hence, in our sample, the initial serum urea concentration > 8 mmol/l was identified as an important predictive factor for the severity of AP (p = 0.0002, OR 4.227) (Tab. 2).

Data processing and analysis

We evaluated each of the clinical and laboratory parameters in our data set and found that several of the examined parameters did not show a statistically significant power ($p \geq 0.05$) of predicting the severity of acute pancreatitis at the time of hospital admission. These parameters are repeat episode of AP (p = 0.395), obesity with BMI > 30 (p = 0.117), age > 60 let (p = 0.115), duration of symptoms prior to commencement of intensive hydration therapy > 24 hours (p = 0.010), haematocrit level < 0.43 in men and < 0.38 in women (p = 0.306).

Both initial leucocytosis >12x10^9/l (p < 0.0001), and the presence of clinically expressed SIRS on initial examination (p < 0.0001) proved unequivocally to be statistically significant. Since leucocytosis is part of the broader set of criteria for SIRS, the authors made a consensual decision to include the presence of SIRS as a predictive factor in their proposed scoring system.

All of the variables that were found during the univariate analysis to be statistically significant in relation to the severity of

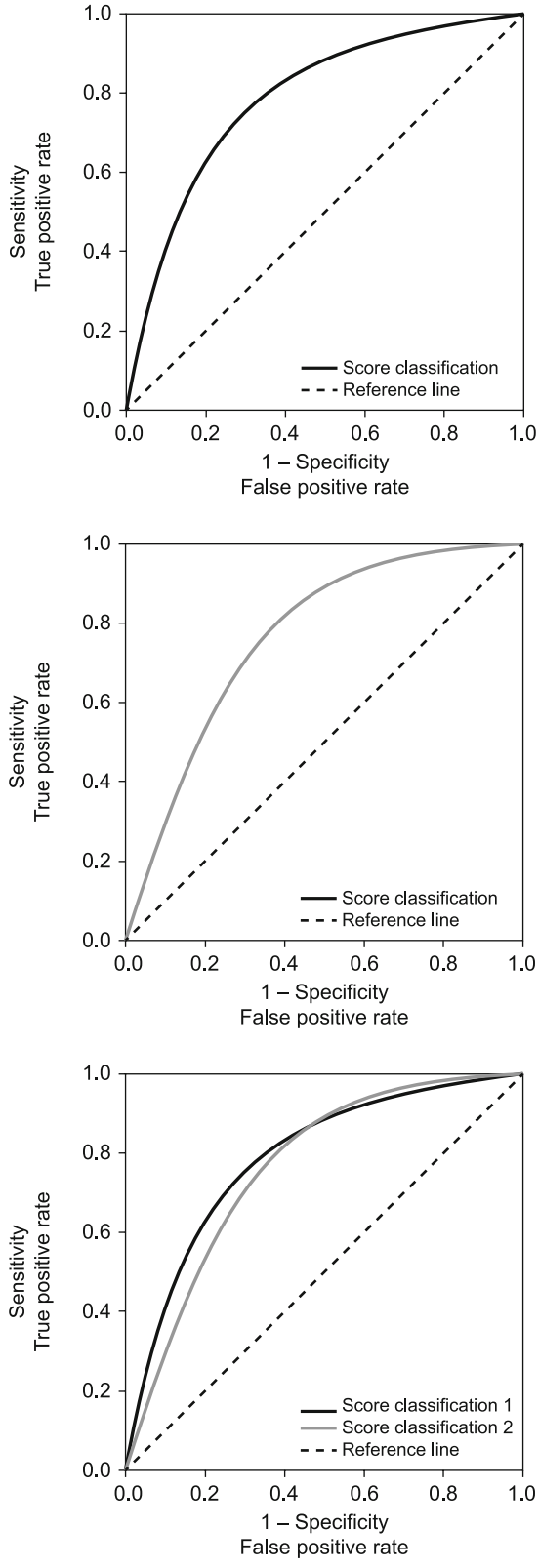

Fig. 2. Sensitivity of APAS score, Variants 1 and 2.

Tab. 4. Acute Pancreatitis Admission score.

	YES	NO
Presence of SIRS	3 points	0 points
Calcium <2.1 mmol/l or Ca++ <1.15 mmol/l	3 points	0 points
History of DM type 2	2 points	0 points
Urea> 8 mmol/l	1 point	0 points
Venous Lactate > 2 mmol/l	1 point	0 points

Total score 0–3 points: mild acute pancreatitis. Total score 4–10 points: moderately severe or severe acute pancreatitis.

AP were then, in the next stage of our analysis, evaluated in multivariate analyses. These analyses revealed that in our sample, there are five parameters with a statistically most significant power of predicting the severity of AP and allocation of patients either to group A or group B (Tabs 2, 3).

According to the odds ratio we then assigned each of these parameters with weight of 1, 2 or 3 points to create a simple scoring system for acute pancreatitis at the time of patient admission, which we refer to as APAS (Acute Pancreatitis Admission Score) as follows: 3 points for the presence of SIRS, 3 points for hypocalcaemia, 2 points for the history of type 2 diabetes mellitus, 1 point for lactate> 2 mmol/l, and 1 point for serum urea concentration > 8 mmol/l 1 point (Tab. 4).

ROC analysis

The specificity and sensitivity of the proposed scoring system were then evaluated for various APAS cut-off scores. Of all the possible APAS score values (0–10 points), statistical tests revealed that the two most effective cut-off values for patient allocation to group B are APAS ≥ 4 points and APAS ≥ 5 points (Fig. 2).

Considering the first of these, APAS ≥ 4 points, 215 patients in our sample had scores below this cut-off, i.e, APAS ≤ 3 points. Of those, 200 patients were allocated, according to the severity of their disease, to group A and 15 patients to group B. There were 97 patients with APAS ≥ 4 points; of these, 31 were allocated to group A and 66 to group B (Tab. 5).

Considering the second cut-off value, APAS ≥ 5 points, 244 patients in our sample had scores below this cut-off value, i.e, APAS ≤ 4 points; of these, 218 patients were allocated to group A and 26 to group B. There were 68 patients with APAS ≥ 5 points, while 13 of these were allocated to group A and 55 to group B.

When using the lower cut-off value, APAS ≥ 4 points, the prediction of allocating a patient to group B had a sensitivity of 81 % (95% CI, 71–89 %) and a specificity of 87 % (95% CI, 81–91 %). In our sample of 312 patients, the positive predictive value of APAS was 0.68, and the negative predictive value was 0.93, with accuracy of 0.85 (95% CI 0.81–0.89), Joudens J index 0.68.

Tab. 5. APAS Score, 2 variants in ROC analysis.

Variant 1: Cut-off ≥ 4 points	APAS 0–3 points	APAS 4–10 points
Group A	200	31
Group B	15	66
Variant 2: Cut-off ≥ 5 points	APAS 0–4 points	APAS 5–10 points
Group A	218	13
Group B	26	55

When using the higher cut-off value, APAS ≥ 5 points, the prediction of allocating a patient to group B had a sensitivity of 68 % (95%CI, 57–78 %) and a specificity of 94 % (95% CI, 91–97 %). The positive predictive value of APAS in our sample was 0.81, and the negative predictive value was 0.89, with accuracy of 0.87 (95% CI, 0.83–0.91), Joudens J index 0.62 (Tab. 5, Fig. 2).

The comparison of sensitivity, specificity, positive and negative predictive values, accuracy and Joudens J index values for these two models led us to establishing the final cut-off value as APAS ≥ 4 points for group B of patients, i.e, for those with moderately severe or severe acute pancreatitis.

Discussion

There can be no doubt that acute pancreatitis is a disease of unpredictable severity. At admission, patients present with a single dominant symptom, which is abdominal pain; this is a subjective symptom that is difficult to measure or quantify. At the time of their admission, patients rarely express complications, either local (necrosis, fluid collection) or systemic (organ failure).

Numerous scoring systems have been developed in an attempt to predict the severity of the disease and the risk of local or organ complications. The sensitivity and specificity of many of these scoring systems is lower than what would be required in clinical practice, which is likely due to the highly enigmatic nature of acute pancreatitis, which presents differently in each patient. A further disadvantage of certain scoring systems is that they are designed for general use in internal medicine rather than selectively for acute pancreatitis (APACHE II score). Other systems such as Ranson score and Glasgow score require the parameters to be monitored over time (at initial examination and during following 24 or 48 hours), which renders any risk stratification on the first day of hospitalisation futile (24).

One simple system that has very good sensitivity and specificity as a predictor of the severity of AP is the BISAP score, which assesses the risk on the basis of 5 parameters particularly on qualitative change in consciousness, age > 60 years, presence of SIRS, pleural fluid and raised urea concentration (24). In this study, the objective was also to identify a simple and accessible combination of parameters that could predict the course of the disease on the day of admission to hospital.

Hence, we chose to record clinical and laboratory data that should be available at any hospital, at any time of day, on any day of the week. After subjecting our collected data to univariate and multivariate analysis, we identified the 5 statistically most significant parameters ($p < 0.05$) and combined these into a simple, clear scoring system, which we refer to as the APAS (The Acute Pancreatitis Admission score).

Following statistic processing, two models were established for our sample, in which the scoring system had a good ability to

predict the course of acute pancreatitis: one with a cut-off value at APAS ≥ 4 points and the second with a cut-off value at APAS ≥ 5 points, indicating a moderately severe or severe course of AP. The comparison of sensitivity, specificity, positive and negative predictive values, accuracy, and Joudens J index values for these two models led us to establish the final cut-off value as ASAP ≥ 4 body for group B patients, i.e, for those with moderately severe or severe acute pancreatitis. Determining which patients are at high risk of local or organ complications was our primary aim in this study, since as soon as these patients are admitted to hospital, they ought to be accommodated on monitored beds in intensive care units. According to Harrison et al, 75 % of patients with severe AP were transferred to ICU within 72 hours of their admission to hospital, with a median of 24 hours (25). Wu et al point out that any scoring systems requiring more than 24 hours to establish patient risk stratification could be a waste of time in the case of a critically ill patient (26).

Our sample of patients confirms the high percentage of patients in need of being transferred to monitored beds within the first 72 hours of hospitalisation. In addition to standard beds and intensive care units (ICU), our department also has an intermediate care room (IMCU) equipped with monitored beds as part of the standard ward, which has great benefits for the care we can provide. There were 11 of the 30 patients with severe AP who were initially admitted directly to the ICU; 7 to the intermediate care room and 12 to standard beds. Within 72 hours of admission, two patients had to be transferred from the intermediate room to the ICU and as many as 10 patients required transferral from standard beds to monitored beds (7 to the ICU and 3 to the IMCU). There were 9 of the 51 patients with moderately severe AP who were admitted directly to the ICU, 14 to the IMCU and 28 to standard beds. Within 72 hours of their admission, 2 of these patients were transferred from the IMCU to the ICU and 11 patients were transferred from standard beds to monitored beds (1 to the ICU and 10 to the IMCU). The scoring system we have developed is an attempt of addressing this situation and enabling the risk stratification of patients with AP at the time of their admission to hospital.

As the authors of this study, we are aware that our analysis is limited by the rather low number of patients in our sample and that our data collection was restricted to just one department. Moreover, some of our data are dependent on information provided by the patients themselves about their medical history (exact duration of their pain), and some comorbidities may not have been present prior to hospitalisation (during the course of this study on 312 patients, 7 patients who stated on admission that they did not have a history of diabetes were found on initial examination to have hyperglycaemia and were thus subjected to further testing and released with a newly confirmed diagnosis of diabetes mellitus type 2). Initial calcaemia was determined in some patients as a measurement of total serum calcium, while in others it was measured as an ionized fraction using POCT analysis; in both cases, hypocalcaemia was defined based on the valid ranges stipulated by the biochemical laboratory of the Military University Hospital in Prague. Our inclusion of the frequently discussed and imprecise criteria for SIRS (tachycardia may be affected by the presence of atrial fibrillation with faster ventricular response or by failure to take antiarrhythmic medication, etc.) may also have limited accuracy. On the other hand, the SIRS criteria are generally well known among doctors and regularly used, and the presence of persistent signs of SIRS substantially increases the risk of multi-organ failure and death with AP (25 % with persistent SIRS, 8 % with transient SIRS, 0.7 % without SIRS) (24).

It is difficult and problematic to compare the sensitivity and specificity of our scoring system with those already used and recognised worldwide. This is because the majority of previously published scoring systems were developed on the basis of a far larger sample of patients and were generally designed to detect severe acute pancreatitis or to determine the risk of death among patients with acute pancreatitis. We focused our study on predicting the severity of acute pancreatitis, specifically on predicting a moderately severe or severe course of the disease as defined according to the Atlanta classification. Diverse publications find various levels of specificity and sensitivity for the same systems, dependent on the number of patients or the number of studies. The meta-analysis by Gao et al. reports that BISAP score ≥ 3 points was associated with a substantially higher risk of severe acute pancreatitis (DOR = 18.08; 95% CI, 8.27–39.55; $p < 0.05$) with a sensitivity of 51 % (43–60 %) and specificity of 91% (89–92 %). Patients with APACHE II score ≥ 8 points had a significantly higher risk of severe AP (DOR = 10.77; 95% CI, 6.80–17.07; $p < 0.05$), with a sensitivity of 83% (95% CI, 77–88 %) and a specificity of 59% (95% CI, 56–63 %). Ranson score ≥ 3 points was also associated with a higher risk of severe AP (DOR = 13.35; 95% CI, 4.53–39.36; $p < 0.05$), with sensitivity of 66 % (95% CI, 59–72 %) and specificity of 78 % (95% CI, 76–81 %) (27).

In our sample of patients, we attempted to predict the severity of acute pancreatitis on the day of hospital admission, with the aim of identifying both those at risk of a severe form of the disease and also those at risk of a moderately severe form, i.e, all patients at risk of developing local or organ complications. A score of APAS ≥ 4 points predicted moderately severe or severe AP with sensitivity of 81 % (95% CI, 71–89 %) and specificity of 87 % (95% CI, 81–91 %), positive predictive value of 0.68, negative predictive value of 0.93, accuracy of 0.85 (95% CI 0.81–0.89), and Joudens J index of 0.68. Allowing for the above-discussed limitations, the sensitivity and specificity of our simple scoring system is practically comparable to the previously published and widely used scoring systems we have mentioned (Tab. 5, Fig. 2).

Conclusion

Based on an analysis of simple parameters that are commonly available at the time of a patient's admission to hospital with acute pancreatitis, we have developed a system that enables the severity of the disease to be predicted. All the details required for our scoring system can be obtained 24 hours a day, and the system does not require any parameters to be monitored over time.

Our simple APAS system is designed to help with the triage of patients with acute pancreatitis and to improve risk estimates on the day of admission to hospital, in particular as regards the risk of developing organ failure.

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