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ORIGINAL ARTICLE

Value of the revised Atlanta classification (RAC) and determinant-based classification (DBC) systems in the evaluation of acute pancreatitis

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ABSTRACT

Objective: Since increasing acute pancreatitis (AP) severity is significantly associated with mortality, accurate and rapid determination of severity is crucial for effective clinical management. This study investigated the value of the revised Atlanta classification (RAC) and the determinant-based classification (DBC) systems in stratifying severity of acute pancreatitis.

Methods: This retrospective observational cohort study included 480 AP patients. Patient demographics and clinical characteristics were recorded. The primary outcome was mortality, and secondary outcomes were admission to intensive care unit (ICU), duration of ICU stay, and duration of hospital stay.

Results: Based on the RAC classification, there were 295 patients with mild AP (MAP), 146 patients with moderate-to-severe AP (MSAP), and 39 patients with severe AP (SAP). Based on the DBC classification, there were 389 patients with MAP, 41 patients with MSAP, 32 patients with SAP, and 18 patients with critical AP (CAP). ROC curve analysis showed that the DBC system had a significantly higher accuracy at predicting organ failure compared to the RAC system ($p < .001$). Multivariate regression analysis showed that age and ICU stay were independent risk factors of mortality.

Conclusion: The DBC system had a higher accuracy at predicting organ failure. Age and ICU stay were significantly associated with risk of death in AP patients. A classification of CAP by the DBC system should warrant close attention, and rapid implementation of effective measures to reduce mortality.

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Acute pancreatitis; revised Atlanta classification (RAC); determinant-based classification (DBC); mortality; organ failure

Introduction

Acute pancreatitis (AP), a common acute abdominal disease, is characterized by acute upper abdominal pain and elevated serum amylase or lipase levels. AP has a worldwide prevalence of 49,734 cases/100,000 people and imposes a significant mental, physical and economic burdens on the patient[1,2]. Biliary AP is the most common type of AP in China, while in Western countries AP is most commonly caused by alcoholism[3]. Definitive diagnosis of AP in patients with atypical symptoms is achieved by abdominal imaging[4]. It is estimated that micro-stones are an important cause of AP in some patients, and cholecystectomy is recommended for hospitalized patients with mild biliary AP, and after the first recurrence of AP[5,6]. Endoscopic retrograde cholangiopancreatography (ERCP) is used to confirm pancreatic duct rupture in patients with severe AP (SAP), following which the endoscopic sphincterotomy (EST) procedure is performed to remove stones and relieve the obstruction. Early ERCP (within 24 h of admission) has been shown to reduce morbidity and mortality in AP patients with concomitant biliary sepsis[7,8], while magnetic resonance cholangiopancreatography (MRCP) and other non-invasive procedures are used for mild AP (MAP)[9].

The overall mortality of AP is 5%–10%, and the mortality in patients with multiple organ failure (MOF) is as high as 30–50%[10]. Timely diagnosis is crucial for effective therapy for AP, and an early determination of AP severity is key for efficient clinical management and for improvement of prognosis. The original Atlanta criteria (OAC) proposed guidelines in 1992 based on which AP patients were diagnosed with mild acute pancreatitis (MAP) or severe acute pancreatitis (SAP)[4]. These guidelines were revised to include a classification of moderate-to-severe acute pancreatitis (MSAP) based on the presence of transient organ failure[11–13]. Recent studies showed that patients with a classification of MSAP had lower mortality rates and better prognosis compared to patients with a classification of SAP, suggesting that the revision of the Atlanta classification (RAC) system was a better reflection of disease severity, and could be a useful tool to improve therapeutic efficacy and reduce mortality[14,15]. It has also been suggested that RAC reflects the dynamic characteristics of AP, especially during the early stage[16].

The finding that patients with necrotic pancreatic infection and organ failure had an extremely high mortality rate led to the development of the determinant-based classification (DBC) system, which added a fourth classification of critical

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acute pancreatitis (CAP). A diagnosis of CAP is based on the presence of pancreatic necrosis and infection with organ failure[17,18]. The new classification system was based on focal and systemic factors (determinants) related to disease severity, made monitoring more convenient, and was helpful for timely treatment for AP[19–21].

Since patients with infectious necrotic AP had significantly higher mortality compared to aseptic necrotic AP patients[22], and infectious necrosis often occurs at 7–10 days after hospitalization[23–25], accurate determination of AP severity within the first 48 h after admission is crucial for the subsequent management of AP[26]. A number of studies concluded that the RAC and DBC systems were both effective in evaluating the severity of AP for guiding clinical management[27–30]. However, it is important to evaluate and compare these systems in the context of clinical outcomes in order to gain novel insights to improve clinical management of AP patients. In this study, we used a large cohort to evaluate which classification system would be more likely to predict the prognosis and establish clinical guidance of AP patients in China.

Methods

Patients

This retrospective observational cohort study recruited a total of 480 consecutive AP patients at the Tongji Hospital of the Shanghai Tongji University between January 2013 and December 2015. All 550 potentially eligible patients included in this study were diagnosed with AP based on the criteria of the Atlanta classification system[31], which defines a diagnosis of AP as the presence of any two of the following presentations: (1) abdominal pain consistent with AP (acute, abrupt, persistent, intense upper abdominal pain with back radiation); (2) serum amylase and/or lipase of >3 times the upper limit of normal; and (3) AP-like features observed in the enhanced CT, MRI or abdominal ultrasonography. Exclusion criteria were: (1) age <18 years old, (2) 32 patients with incomplete records of clinical characteristics; and 3) 38 patients with presence of concomitant severe heart, lung, liver, or kidney disease (Supplementary Figure S1).

Methods

The parameters recorded for this study were: (1) general information including name, hospitalization number, gender, age, cause of AP and symptoms; (2) laboratory parameters including white blood cells counts, absolute neutrophil count counts, glutamic-pyruvic transaminase and glutamic oxalacetic transaminase levels, lactic dehydrogenase levels, Ca, Creatinine, urea nitrogen, and PaO_2 levels; (3) imaging results from ultrasonography, plain CT, enhanced CT, and MRCP of the pancreas and peri-pancreas; (4) hospitalization-related information including duration of hospital stay, duration of fasting, pharmacotherapy, therapy in intensive care unit (ICU), ICU stay, use of ERCP, mechanical ventilation, interventional therapy, surgical therapy, and type and duration of organ failure; (5) disease outcome (cure, remission, death, automatically discharged) and type of complications; (6) on the basis of above parameters, patients were evaluated using the Ranson scoring system (used to evaluate the disease severity), the Bedside Index for Severity in Acute Pancreatitis (BISAP), the CT severity index (CTSI), and the Marshall scoring system (used to evaluate organ failure); patients were also evaluated by the BISAP score within 24 h, the Ranson score within 48 h, the CTSI score, the Marshall score and the SOFA score; (7) AP classification based on DBC and RAC.

The primary outcome of the study was mortality, and secondary outcomes were admission to ICU, duration of ICU stay and duration of hospital stay.

Statistical analysis

Categorical data is presented as counts and percentages with chi-square or Fisher's exact test. Continuous variables for non-normality data are expressed as median (IQR), and the Kruskal–Wallis test was used to compare differences between different classifications and continuous variables. A post-hoc comparison was performed by Mann–Whitney *U* with a significance level of .05. Receiver operating characteristic (ROC) curve analysis was performed to compare the accuracy of the RAC and DBC systems in predicting clinical outcomes. Univariate and multivariate logistic regression analyses were performed to determine significant factors associated with death for acute pancreatitis. Variables with significance ($p < .05$) by univariate analysis were selected and evaluated by multivariate logistic regression models. Statistical analyses were performed with IBM SPSS statistical software version 22 for Windows (IBM Corp., Armonk, NY, USA). A two-tailed p value <.05 indicated statistical significance.

Results

Baseline of study subjects

Our study population of 480 AP patients comprised 278 males (57.9%) and 202 females (42.1%). The median age was 57 years. A description and comparison of the two different classification systems are summarized in Table 1. The RAC system classifies patients as MAP (no organ failure [OF] or focal or systemic complications), MSAP (transient OF and/or focal or systemic complications), and SAP (persistent OF). The DBC system classifies patients as MAP (no pancreatic [peripancreatic] necrosis and no OF), MSAP (aseptic pancreatic [peripancreatic] necrosis and transient OF), SAP (infectious pancreatic [peripancreatic] necrosis), and critical AP (infectious pancreatic [peripancreatic] necrosis and persistent OF). Based on the RAC classification, there were 295 patients with MAP, 146 patients with MSAP, and 39 patients with SAP. Based on the DBC classification, there were 389 patients with MAP, 41 patients with MSAP, 32 patients with SAP, and 18 patients with CAP (Table 2).

Total parenteral nutrition (TPN) was administered to 7 patients (1.5%) who had gastrointestinal symptoms (nausea, vomiting and abdominal distension) and extremely poor gastrointestinal function, making food intake via mouth impossible. Enteral nutrition (EN) was administered to 219 patients (45.6%), of whom 188 patients received gastric tube

Table 1. Revision of Atlanta classification and determinant-based classification for AP.

Classification	Type	Definition
Revision of Atlanta classification (RAC)	Mild AP (MAP)	No OF and focal or systemic complications
	Moderate-to-severe AP (MSAP)	Transient OF and/or focal/systemic complications
	Severe AP (SAP)	Persistent OF
Determinant-based classification (DBC)	Mild AP (MAP)	No pancreatic (peripancreatic) necrosis and no OF
	Moderate-to-severe AP (MSAP)	Aseptic pancreatic (peripancreatic) necrosis and/or transient OF
	Severe AP (SAP)	Infectious pancreatic (peripancreatic) necrosis
	Critical AP (CAP)	Infectious pancreatic (peripancreatic) necrosis and persistent OF

Abbreviations. OF, organ failure; transient OF, <48 h; persistent OF, ≥48 h.

placement and 31 patients received nasobiliary duct placement (Table 2).

A total of 360 study patients (75%) received antibiotic therapy. A total of 101 patients received prophylactic antibiotics (data not shown). A significantly higher percentage of patients classified as MSAP and SAP received antibiotics compared to patients classified as MAP in the RAC system. Additionally, a significantly higher percentage of patients classified as CAP received antibiotics compared to patients classified as MAP and MSAP in the DBC system (Table 2). In our study, 36 patients (7.5%) had ERCP for concomitant cholangitis or biliary obstruction (Table 2). Cure was observed in 81 patients with AP; remission was noted in 371 patients with AP; discharge requirements were observed in 16 patients with AP; 12 patients died of AP (data not shown).

The three RAC groups differed significantly in: (1) demographic variables like median age (55 vs. 65 vs. 58 years, $p < .001$); (2) tenderness and cholelithiasis ($p < .001$ and $p = .002$, respectively); (3) median duration of fasting (10 days vs. 6 days vs. 4 days, $p < .001$); (4) clinical treatment variables like oxygen inhalation, gastric tube placement, nasobiliary duct placement, antibiotic used, blood purification and mechanical ventilation (all $p < .001$), and type of interventional therapy and TPN used ($p = .05$ and $p = .017$, respectively); (5) clinical outcome variables like percentage of organ failure, ICU stay and overall survival (all $p < .001$), and median duration of hospital stay (15 vs. 10 vs. 9 days, $p < .001$).

The significant differences between the four DBC groups were similar to those seen between the RAC groups except for differences in age, birthplace and alcohol consumption. The four DBC groups did not differ significantly in median age ($p = .451$), but differed significantly in birthplace and history of alcohol consumption ($p = .018$ and $p = .03$, respectively) (Table 2).

Comparison of accuracy of revised Atlanta classification and determinant-based classification in predicting clinical outcomes

ROC curve analysis was used to compare the accuracy of the RAC and DBC systems in predicting clinical outcomes including mortality, organ failure, ICU stay and duration of hospital stay ≥14 days (third quartile). The accuracy of the RAC and DBC systems at predicting mortality is shown in Figure 1. For the RAC system, the area under the curve (AUC) was 0.938 (95% CI, 0.913–0.958); for the DBC system, the AUC was 0.949 (95% CI, 0.926–0.967). The pairwise comparison of ROC curves showed that the difference between the AUCs was 0.011, which was not significantly different ($p = .370$). The accuracy of the RAC and DBC systems at predicting organ failure is shown in Figure 2. For the RAC system, the AUC was 0.943 (95% CI, 0.918–0.962); for the DBC system, the AUC was 0.978 (95% CI, 0.960–0.989). The pairwise comparison of ROC curves showed that the difference between the AUCs was 0.035, and this difference was significant ($p < .001$). The accuracy of the RAC and DBC systems at predicting ICU stay is shown in Figure 3. For the RAC system, the AUC was 0.921 (95% CI, 0.894–0.944); for the DBC system, the AUC was 0.924 (95% CI, 0.896–0.946). The pairwise comparison of the ROC curves showed that the difference between the AUCs was 0.003 which was not significantly different ($p = .924$). The accuracy of the RAC and DBC systems in predicting duration of hospital stay ≥14 days (third quartile) is shown in Figure 4. For the RAC system, the AUC was 0.637 (95% CI, 0.592–0.680); for the DBC system, the AUC was 0.605 (95% CI, 0.560–0.649). The pairwise comparison showed that the difference between the AUCs was 0.032, which was not significantly different ($p = .117$).

Logistic regression analysis of factors associated with the risk of death for acute pancreatitis

Univariate logistic regression analysis revealed that age (OR = 1.06, $p = .005$) and ICU stay (yes vs. no, OR = 23.163, $p < .001$) were significantly associated with death in AP patients (Table 3). Variables which were statistically significant on the univariate analysis ($p < .05$) were selected into the multivariate logistic regression to determine their association with mortality in AP patients. Multivariate logistic regression analysis showed that the odds of death were significantly increased with increasing age (OR = 1.063, $p = .003$). The odds of death were also significantly increased with ICU stay (yes vs. no, OR = 34.812, $p < .001$).

Discussion

In this study, we evaluated the RAC and DBC classification systems to understand which classification system would be more likely to predict the prognosis and clinical outcomes in AP patients. Our data validated earlier results which showed that both the RAC and DBC systems could accurately classify AP according to its severity. The novel findings from our study were: (1) the DBC system was significantly more accurate at predicting organ failure compared to the RAC system, and (2) age and ICU stay were significantly associated with risk of death in AP patients.

Table 2. Baseline of study subjects.

	Total ($N = 480$)	RAC			p-value	DBC				p-value
		MAP ($N = 295$)	MSAP ($N = 146$)	SAP ($N = 39$)		MAP ($N = 389$)	MSAP ($N = 41$)	SAP ($N = 32$)	CAP ($N = 18$)	
Demography										
Age (years)	57 (44, 71)	55 (41, 67)	65 (55, 79)[a]	58 (43, 80)	<.001*	58 (44, 71)	56 (45, 66)	59 (43, 80)	49 (35, 71)	.451
Gender, male	278 (57.9)	173 (58.6)	85 (58.2)	20 (51.3)	.679	225 (57.8)	28 (68.3)	17 (53.1)	8 (44.4)	.327
Birthplace, Shanghai	378 (78.8)	230 (78.0)	122 (83.6)	26 (66.7)	.063	311 (79.9)	31 (75.6)	27 (84.4)	9 (50.0)[ac]	.018*
Seizure frequency					.433					.938
Never	408 (85.0)	250 (84.7)	125 (85.6)	33 (84.6)		328 (84.3)	37 (90.2)	27 (84.4)	16 (88.9)	
Once	46 (9.6)	31 (10.5)	10 (6.8)	5 (12.8)		39 (10.0)	2 (4.9)	4 (12.5)	1 (5.6)	
Repeatedly	26 (5.4)	14 (4.7)	11 (7.5)	1 (2.6)		22 (5.7)	2 (4.9)	1 (3.1)	1 (5.6)	
Smoking	108 (22.5)	65 (22.0)	35 (24.0)	8 (20.5)	.858	84 (21.6)	12 (29.3)	7 (21.9)	5 (27.8)	.670
Alcohol consumption	71 (14.8)	43 (14.6)	20 (13.7)	8 (20.5)	.559	52 (13.4)	10 (24.4)	3 (9.4)	6 (33.3)[ac]	.030*
Symptom, abdominal pain	462 (96.3)	282 (95.6)	142 (97.3)	38 (97.4)	.632	373 (95.9)	40 (97.6)	32 (100.0)	17 (94.4)	.627
Cardinal signs, tenderness	373 (77.7)	210 (71.2)	128 (87.7)[a]	35 (89.7)[a]	<.001*	297 (76.3)	30 (73.2)	31 (96.9)[ab]	15 (83.3)	.046*
Cholelithiasis	121 (25.2)	58 (19.7)	49 (33.6)[a]	14 (35.9)[a]	.002*	95 (24.4)	7 (17.1)	10 (31.3)	9 (50.0)[ab]	.045*
Cause of disease					.736					.247
Biliary	194 (40.4)	126 (42.7)	55 (37.7)	13 (33.3)		164 (42.2)	14 (34.1)	9 (28.1)	7 (38.9)	
Alcoholic	38 (7.9)	21 (7.1)	13 (8.9)	4 (10.3)		25 (6.4)	8 (19.5)	2 (6.3)	3 (16.7)	
Hyperlipidemic	83 (17.3)	50 (16.9)	26 (17.8)	7 (17.9)		68 (17.5)	5 (12.2)	6 (18.8)	4 (22.2)	
Post-ERCP	7 (1.5)	6 (2.0)	0 (0)	1 (2.6)		5 (1.3)	1 (2.4)	1 (3.1)	0 (0)	
Unknown	88 (18.3)	49 (16.6)	32 (21.9)	7 (17.9)		68 (17.5)	10 (24.4)	8 (25.0)	2 (11.1)	
Others	70 (14.6)	43 (14.6)	20 (13.7)	7 (17.9)		59 (15.2)	3 (7.3)	6 (18.8)	2 (11.1)	
Clinical treatment										
Length of fasting (days)	5 (3, 8)	4 (3, 7)	6 (4, 8)[a]	10 (4, 16)[ab]	<.001*	5 (3, 7)	6 (4, 8)	7 (4, 15)[a]	16 (10, 25)[abc]	<.001*
Oxygen inhalation	178 (37.1)	65 (22.0)	77 (52.7)[a]	36 (92.3)[ab]	<.001*	120 (30.8)	15 (36.6)	26 (81.3)[ab]	17 (94.4)[ab]	<.001*
Gastric tube placement	188 (39.2)	71 (24.1)	84 (57.5)[a]	33 (84.6)[ab]	<.001*	124 (31.9)	21 (51.2)[a]	25 (78.1)[ab]	18 (100.0)[abc]	<.001*
Nasobiliary duct placement	31 (6.5)	11 (3.7)	8 (5.5)	12 (30.8)[ab]	<.001*	15 (3.9)	3 (7.3)	7 (21.9)[a]	6 (33.3)[ab]	<.001*
ERCP	36 (7.5)	22 (7.5)	13 (8.9)	1 (2.6)	.410	29 (7.5)	4 (9.8)	2 (6.3)	1 (5.6)	.934
Antibiotic used	360 (75.0)	195 (66.1)	130 (89.0)[a]	35 (89.7)[a]	<.001*	285 (73.3)	29 (70.7)	28 (87.5)	18 (100.0)[ab]	.021*
Interventional therapy	4 (0.8)	0 (0)	2 (1.4)	2 (5.1)[a]	.005*	0 (0)	1 (2.4)	1 (3.1)	2 (11.1)[a]	<.001*
TPN used	7 (1.5)	2 (0.7)	2 (1.4)	3 (7.7)[a]	.017*	3 (0.8)	0 (0)	1 (3.1)	3 (16.7)[ab]	.002*
Blood purification	6 (1.3)	0 (0)	0 (0)	6 (15.4)[ab]	<.001*	0 (0)	0 (0)	2 (6.3)[a]	4 (22.2)[ab]	<.001*
Mechanical ventilation	16 (3.3)	0 (0)	2 (1.4)	14 (35.9)[ab]	<.001*	1 (0.3)	1 (2.4)	5 (15.6)[a]	9 (50.0)[abc]	<.001*
Surgery	39 (8.1)	19 (6.4)	17 (11.6)	3 (7.7)	.169	32 (8.2)	3 (7.3)	2 (6.3)	2 (11.1)	.923
Clinical outcome										
Organ failure					<.001*					<.001*
No	419 (87.3)	295 (100.0)	123 (84.2)[a]	1 (2.6)[ab]		389 (100.0)	19 (46.3)[a]	11 (34.4)[ab]	0 (0)[abc]	
Transient	25 (5.2)	0 (0)	23 (15.8)	2 (5.1)		0 (0)	22 (53.7)	3 (9.4)	0 (0)	
Continuous	36 (7.5)	0 (0)	0 (0)	36 (92.3)		0 (0)	0 (0)	18 (56.3)	18 (100.0)	
ICU stay	19 (4.0)	1 (0.3)	2 (1.4)	16 (41.0)[ab]	<.001*	2 (0.5)	0 (0)	5 (15.6)[ab]	12 (66.7)[abc]	<.001*
Length of ICU (days)[d]	3 (2, 13)	2 (2, 2)	4 (3, 5)	4 (2, 15)	.540	3 (2, 3)	–	3 (2, 5)	8 (3, 21)	.355
Length of hospital stay (days)	9 (6, 14)	9 (6, 13)	10 (7, 16)[a]	15 (10, 33)[ab]	<.001*	9 (6, 13)	10 (7, 13)	14 (6, 25)[a]	27 (14, 40)[abc]	<.001*
Survival					<.001*					<.001*
Death	12 (2.5)	0 (0)	2 (1.4)	10 (25.6)[ab]		0 (0)	2 (4.9)[a]	5 (15.6)[a]	5 (27.8)[ab]	
Alive	468 (97.5)	295 (100.0)	144 (98.6)	29 (74.4)		389 (100.0)	39 (95.1)	27 (84.4)	13 (72.2)	

*Significant differences among subgroups, $p < .05$.
[a]Significant differences with MAP, $p < .05$.
[b]Significant differences with MSAP, $p < .05$.
[c]Significant differences with SAP, $p < .05$.
[d]Nineteen patients were transferred to ICU stay.
Abbreviations. RAC, revision of the Atlanta classification; DBC, determinant-based classification; MAP, mild acute pancreatitis; MSAP, moderate-to-severe acute pancreatitis; SAP, severe acute pancreatitis; CAP, critical acute pancreatitis; ERCP, endoscopic retrograde cholangio-pancreatography; TPN, total parenteral nutrition.

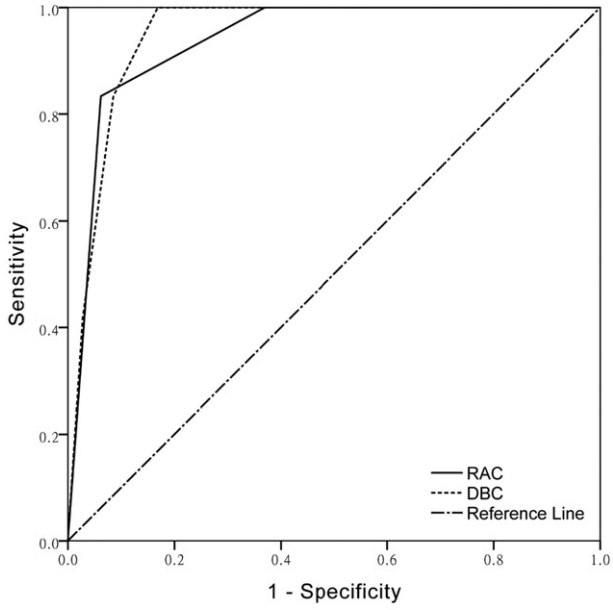

Figure 1. Comparison of accuracy of RAC and DBC in predicting mortality for acute pancreatitis. For RAC, the AUC = 0.938 (95% confidence interval, 0.913–0.958); for DBC, the AUC = 0.949 (95% confidence interval, 0.926–0.967). Pairwise comparison of ROC curves showed that the difference between areas was 0.011 ($p = .370$).

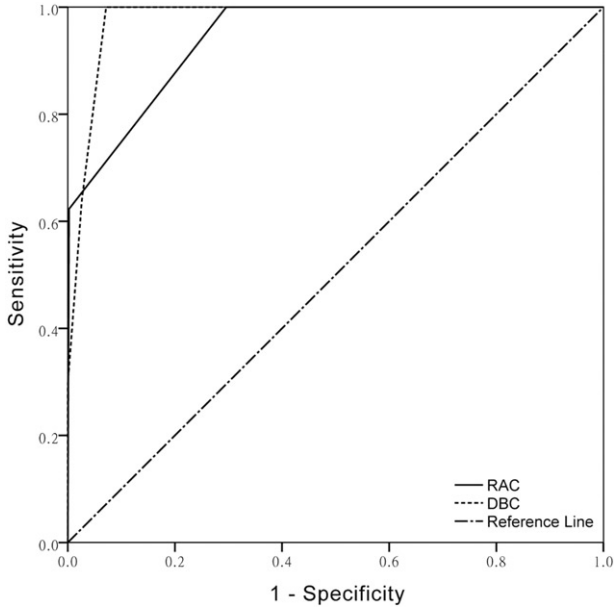

Figure 2. Comparison of accuracy of RAC and DBC in predicting organ failure for acute pancreatitis. For RAC, the AUC = .943 (95% confidence interval, 0.918–0.962); for DBC, the AUC = 0.978 (95% confidence interval, 0.960–0.989). Pairwise comparison of ROC curves showed that the difference between areas was 0.035 ($p < .001$).

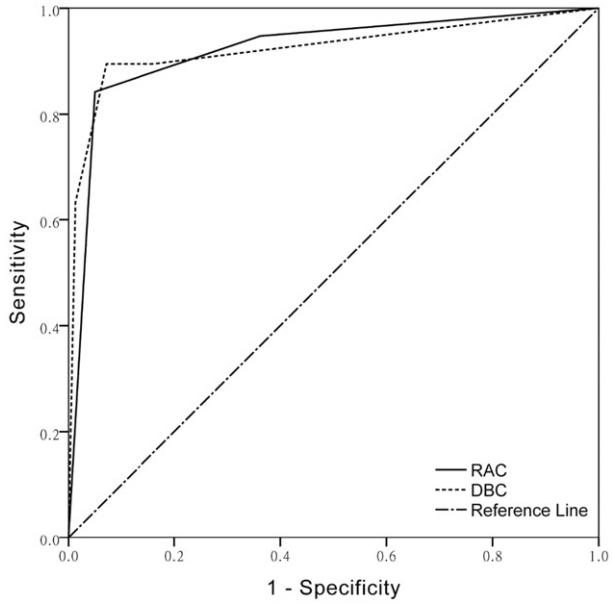

Figure 3. Comparison of accuracy of RAC and DBC in predicting ICU stay for acute pancreatitis. For RAC, the AUC = 0.921 (95% confidence interval, 0.894–0.944); for DBC, the AUC = 0.924 (95% confidence interval, 0.896–0.946). Pairwise comparison of ROC curves showed that the difference between areas was 0.003 ($p = .924$).

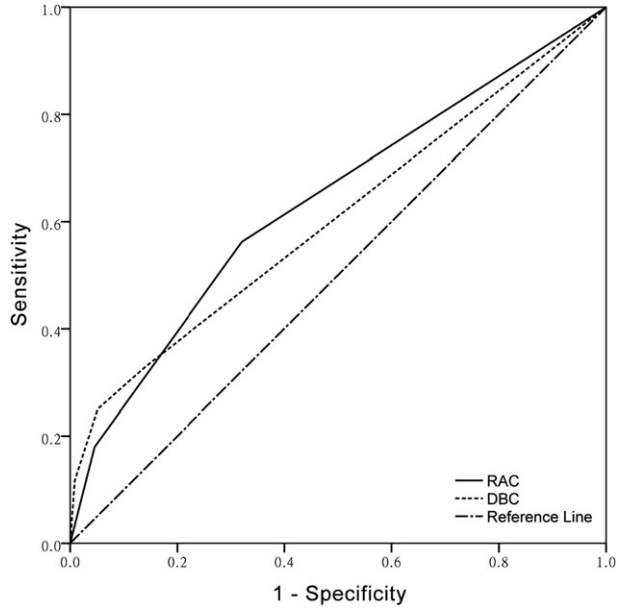

Figure 4. Comparison of accuracy of RAC and DBC in predicting duration of hospital stay ≥14 days (third quartile) for acute pancreatitis. For RAC, the AUC = 0.637 (95% confidence interval, 0.592–0.680); for DBC, the AUC = 0.605 (95% confidence interval, 0.560–0.649). Pairwise comparison of ROC curves showed that the difference between areas was 0.032 ($p = .117$).

It was previously shown that the incidence of AP was higher in males, and alcohol consumption was the most common cause of AP among males, while biliary AP was more common in females[32]. Hyperlipidemia was also reported to be a common cause of AP[33]. These results were consistent with our data which showed that males had a significantly higher incidence of AP compared to females, and that biliary AP was the most common cause of AP, followed by hyperlipidemia and alcoholism. This may be related to the increased incidence of cholelithiasis, obesity and hyperlipidemia among the middle-aged and elderly, acceleration in aging and extended average life expectancy[34,35].

There is currently no consensus on the duration of fasting, and time of resumption of food intake during the treatment period[36]. However, since TPN could result in intestinal mucosal atrophy, gastrointestinal bacterial translocation and elevated risk for infection[37], early resumption of food intake via mouth or enteral nutrition is recommended in order to

Table 3. Logistic regression analysis of factors associated with the risk of death for acute pancreatitis.

	Univariate		Multivariate	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Demography				
Age (years)	1.060 (1.018, 1.104)	.005*	1.063 (1.021, 1.107)	.003*
Gender				
Male (reference)				
Female	1.388 (0.441, 4.367)	.575		
Birthplace				
Non-Shanghai (reference)				
Shanghai	0.805 (0.214, 3.029)	.748		
Seizure frequency				
Never (reference)				
Once	2.015 (0.422, 9.623)	.380		
Repeatedly	1.773 (0.216, 14.556)	.594		
Smoking				
No (reference)				
Yes	0.683 (0.147, 3.165)	.626		
Alcohol consumption				
No (reference)				
Yes	1.157 (0.248, 5.392)	.853		
Cardinal signs, tenderness				
No (reference)				
Yes	1.446 (0.312, 6.704)	.637		
Cholelithiasis				
No (reference)				
Yes	3.070 (0.971, 9.704)	.056		
Cause of disease				
Biliary (reference)				
Alcoholic	1.284 (0.140, 11.813)	.825		
Hyperlipidemic	0.579 (0.064, 5.262)	.628		
Post-ERCP	[a]	[a]		
Unknown	2.262 (0.553, 9.260)	.256		
Others	1.397 (0.250, 7.801)	.703		
ICU stay				
No (reference)				
Yes	23.163 (6.538, 82.060)	<.001*	34.812 (8.088, 149.835)	<.001*
Length of hospital stay (days)	0.981 (0.908, 1.060)	.630		

[a]Parameter group (no patient death, thus logistic regression cannot estimate).
*Statistically significant ($p < .05$).

reduce the incidence of infection, shorten the duration of hospital stay and reduce mortality[22]. In this study, the median duration of fasting was 5 days (range: 1–115 days).

Infection is a common complication of AP that could result in exacerbation of symptoms or death. Our study showed that a significantly higher proportion of patients classified as MSAP or SAP in the RAC system, and patients classified as CAP in the DBC system received antibiotics compared to patients classified in the milder subgroups.

Previous head-to-head comparisons of the Atlanta 1992, Atlanta 2012, and DBC classification systems showed that Atlanta 2012 and DBC systems were superior to Atlanta 1992 in predicting clinical outcomes[38], and the DBC system was a better predictor of the need for intervention, while Atlanta 2012 was a better predictor of length of ICU stay[16]. Our present study directly compared the value of the RAC and DBC classification systems to evaluate specific clinical outcomes. Due to sample size, the SAP and CAP groups of the DBC system were combined as a single subtype, and compared with the SAP group of the RAC system. We found no significant difference in ICU stay or mortality rate between these two groups (Supplementary Table 1). It is important to re-evaluate these findings in a larger sample size.

A retrospective study of 338 patients found significant differences between the different RAC classifications in mortality and ICU stay, although they did not evaluate the incidence of organ failure, time of fasting and use of mechanical ventilation[39]. Our present study extended these findings, and compared a number of additional parameters between patients classified in the different RAC categories. We demonstrated significant differences in mortality, incidence of organ failure, invasive mechanical ventilation, ICU stay, duration of fasting, oxygen inhalation, gastric tube placement, and duration of hospital stay between patients classified as MAP, MSAP and SAP by the RAC system. Our data suggested that the RAC system could accurately stratify AP patients based on severity.

Studies evaluating the DBC classification system reported conflicting results. One retrospective study of 97 patients reported that mortality rates were not significantly different between SAP and CAP patients when the DBC classification system was used[40], while a study of 228 AP patients classified by the DBC system showed that CAP patients had significantly higher mortality rates, more than twice the duration of ICU stay, and a higher percentage of surgical intervention compared to SAP patients[41,42]. Our present study evaluated

mortality rates, ICU stay and a number of additional parameters, and showed that although there was no significant difference in mortality between the SAP and CAP groups of the DBC classification system, the CAP group had: (1) a significantly higher proportion of patients receiving ICU treatment and invasive mechanical ventilation, (2) a significantly higher incidence of organ failure, and 3) a significantly longer hospital stay compared with SAP patients.

Organ failure is a key factor affecting patient prognosis, and has a significant impact on clinical outcome in AP patients. According to the RAC system, SAP refers to the existence of persistent (>48 h) impairment of organ function (single or multiple organs), and organ failure is defined by a Marshall score ≥2 (including respiratory failure, circulatory failure and kidney failure). In the case of the DBC classification system, the most severe patients within the SAP group are classified as CAP, and organ failure is defined by a SOFA score ≥2 (including respiratory, hematological, liver, circulatory, mental and renal failure)[40]. The CAP category comprises patients with combined infectious necrosis and persistent organ failure, and these patients have a worse clinical prognosis compared to patients in the other categories.

We used ROC curve analysis to show that the DBC system was significantly more accurate at predicting organ failure compared to the RAC system. Based on our present findings that more patients classified under the CAP category with the DBC system required invasive mechanical ventilation, required longer hospital stay and had a higher incidence of persistent organ failure, we suggest that a timely determination of CAP according to the DBC criteria is clinically important to guide the clinical management of AP and improve the survival rate. Since only a few patients had CAP in our present study, a larger sample size is necessary to validate the higher accuracy of DBC-based prediction of organ failure compared to the RAC-based prediction. An additional novel finding from our present study was that age and ICU stay were significant risk factors of mortality in AP patients.

In conclusion, classification of AP based on severity is important for guiding the clinical management of AP patients. Our results showed that the RAC and DBC systems could both accurately classify the severity of AP. A classification of CAP by the DBC system should warrant close attention, and rapid implementation of effective measures to reduce the mortality or change the clinical outcome. The major limitations of this study were that it was a single-center, retrospective study, and the number of CAP patients classified by the DBC system was small. Since patients >58 years old who have organ failure may have higher in-hospital mortality, we suggest that an extended ICU monitoring time or a detailed evaluation of organ function may help improve clinical outcomes. The DBC system may be better than the RAC system to classify older patients, and patients with severe/critical acute pancreatitis.

Transparency

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Author contributions: X.W.: guarantor of integrity of the entire study, study concepts, study design, definition of intellectual content, manuscript preparation, manuscript editing and manuscript review. L.Q.: literature research and clinical studies. L.Q. and J.C.: data acquisition, data analysis and statistical analysis.

Declaration of financial/other relationships

X.W., L.Q. and J.C. have disclosed that they have no significant relationships with or financial interests in any commercial companies related to this study or article.

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