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Original Article

Patient- and hospital-based factors at admission associated with outcomes of patients hospitalized for acute pancreatitis: a retrospective cohort study

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Abstract: Although significant effort has been made to diagnose and treat patients with acute pancreatitis (AP), knowledge of the risk factors and their relationship with patient outcomes is still lacking. Little is known about whether clinical outcomes, such as mortality or being cured of AP, may be influenced by certain factors, including season of admission; place of residence; time of admission; insurance status; lifestyle habits, such as smoking; pre-treatment methods and durations; and other clinical conditions at admission. This study aimed to investigate the association between potential risk factors and clinical outcomes in patients with AP. A retrospective cohort study of adult patients at the initial onset of AP was carried out. The patients were identified using a pancreatitis database in the tertiary referral hospital. Information on place of residence, season of admission, insurance status, lifestyle habits and plasma biochemical indexes were retrieved from clinical profiles and reviewed by two independent researchers. Recovery, partially recovery and death were considered to be the categorical primary outcomes and group classification evidence. One-way ANOVA and the chi-square test were performed to compare the differences of all characteristics between the three groups. Adjusted odds ratios and 95% confidence intervals were calculated using multinomial logistic regression. Data of 684 (365 M, 319 F) patients from 2008 to 2012 were retrieved. There were 518, 147 and 19 patients in the recovery, partially recovery and dead groups, respectively, with an overall death rate of 2.7% and a rate of 9.4% among sever acute pancreatitis (SAP) patients. Risk factors for death compared to the recovery group were hypertriglyceridemic acute pancreatitis (HTAP) (OR: 3.364; 95% CI=1.237-9.144; P=0.017); classification of AP (OR: 7.023; 95% CI=2.317-21.288; P=0.001); blood creatinine level (OR: 7.259; 95% CI=2.442-21.575; P<0.001); blood AST level (OR: 11.345; 95% CI=2.355-54.651; P<0.001); and blood albumin level (OR: 3.389; 95% CI=1.032-11.130; P=0.044). Being over 61 years of age was also a risk factor for mortality. Alcoholic AP, severity diagnosis and Alb level were risk factors for poor improvement. None of the hospital-based factors were risk factors for the outcomes. Patients older than 61 years had a higher risk of mortality than those of other ages. Patients who were diagnosed with HTAP or SAP were also at greater risk for mortality. Moreover, blood creatinine, AST and Alb levels, which may be indicative of mild organ dysfunction and malnutrition, could also be considered predictors for mortality.

Keywords: Acute pancreatitis, risk factors, retrospective study

Introduction

Acute pancreatitis (AP), an inflammatory condition leading to pancreatic tissue damage, is a cause of substantial morbidity and mortality [1]. Annually, approximately 210,000 people with AP are admitted to hospitals in the United States, approximately and 5% of which die [2, 3]. Therefore, it is of great importance to know the risk factors related to the outcomes of AP patients, particularly those factors that are related to mortality.

Etiology and age are the most frequently discussed risk factors. Many advances have been made in the diagnosis and treatment of acute pancreatitis, leading to a significant reduction in both morbidity and mortality. However, the relationship between the etiology and outcomes (especially mortality) of acute pancreati-

tis is far from clear. Some studies have reported that mortality is higher in patients with biliary acute pancreatitis or in those with alcoholic AP; others have found no significant difference [4, 5]. Gullo *et al.* [6] found that while the predominant etiology of acute pancreatitis differed in five European countries, there were no significant differences in mortality rates among the various etiologies, and no relation was found between mortality and age.

Several other risk factors also have been suggested, including age [6], a high body mass index (BMI) orobesity [7], and hypercalcemia [8]. Sun et al. [9] published a meta-analysis suggesting that smokers have an elevated risk for AP. Heavy smoking is associated with a lower age at the first episode of acute pancreatitis and a higher risk of recurrence [10].

Although some factors been studied extensively, others have received little attention. For example, Robert [11] conducted a study on the relationship between mortality and five factors, including social isolation, day of admission, recruitment of residents each August, European Working Time Directives (EWTDs) for residents' working hours and hospital size, and found an increased mortality rate for patients admitted with alcoholic acute pancreatitis between August and October, patients admitted in August 2004, and patients admitted to large hospitals for acute pancreatitis overall and particularly those with gallstone etiology. Regarding hospital staffing, during the day shift, an adequate number of medical personnel are available to care for patients appropriately, but during the night shift, the work force decreases significantly. In a multicenter observational study, Neuraz *et al*. reported that ICU-based patient mortality was associated with staff resources and workload in the ICU [12].

In China, certain patient- and hospital-based factors differ from those in Western countries. For example, in China, patients prefer to go directly to tertiary referral hospitals without an initial consultation with a general practitioner. However, because tertiary referral hospitals are commonly located in large cities, those who live in rural areas usually take longer to reach the hospitals for a first-attack diagnosis, particularly in emergency situations such as AP. Additionally, families often gather for celebrations for the Spring Festival, during which many high-fat and high-calorie foods are consumed, along with occasional alcohol intake. In the summer, in most cities and counties, people like to dine out late on grilled meat, seafood and beer. We therefore assume that the place of residence varies and season-specific differences may exist among in-patients, which may also be risk factors for different outcomes.

Little is known about what routine blood tests could uncover risk factors for clinical outcomes, although many studies have verified that biomarkers such as C-reactive protein (CRP), procalcitonin (PCT) and interleukin 6 (IL-6) could predict the severity of AP [13].

In our cohort, patient- and hospital-based factors, as well as blood indices, were analyzed for a better and more comprehensive understanding of AP outcomes.

Material and methods

This retrospective cohort study was conducted in a tertiary referral hospital in Chengdu, China. The study initially included 833 consecutive patients diagnosed with acute pancreatitis (ICD-10) from 2008 to 2012. After verifying all the profiles in a pancreatitis database, data from 684 patients were included in the final analysis (**Figure 1**, flow chart).

A diagnosis of acute pancreatitis requires two of the following three features: (1) abdominal pain consistent with acute pancreatitis (acute onset of a persistent, severe, epigastric pain often radiating to the back); (2) serum lipase activity (or amylase activity) at least three times greater than the upper limit of normal; and (3) characteristic findings of acute pancreatitis on contrast-enhanced computed tomography (CECT) or, less commonly, magnetic resonance imaging (MRI) or trans-abdominal ultrasonography. Data files for patients with any of the following characteristics were excluded: recurrent chronic pancreatitis, traumatic pancreatitis, non-Han Chinese, re-admission with an AP diagnosis, or a pancreatic pseudocyst after AP. Additionally, if significant pieces of data were found to be missing after reading through the chart, the data file was excluded.

All patients were classified into three types according to the revision of the Atlanta classification and definitions by international consensus [14]: mild acute pancreatitis (MAP), moder-

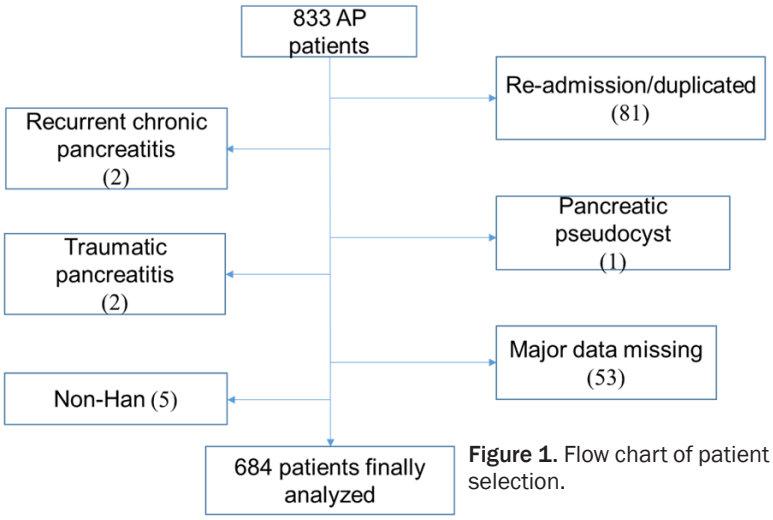

Figure 1. Flow chart of patient selection.

ate severe acute pancreatitis (MSAP) and severe acute pancreatitis (SAP). All patients' diagnoses were reviewed by two independent gastroenterology experts; if a disagreement occurred, the expert panel met to discuss it.

The following information was noted: age, sex, etiology of AP, smoking status, drinking status, season and time of admission, insurance status, place of residence, Acute Physiology and Chronic Health Evaluation II (APACHE II) score (within 24 h), Ranson score (within 48 h), Marshall score on admission, and time interval between AP onset and hospital admission.

Definitions

Biliary acute pancreatitis was defined based on radiologic evidence of 1 or more gallstones or bile duct stones.

The diagnostic criteria for hypertriglyceridemic acute pancreatitis (HTAP) were patients who had a history of hypertriglyceridemia before AP onset and a serum TG level at admission of more than 11.3 mmol/L or more than 5.65 mmol/L with a lactescent serum [16] (**Figure 1**).

Alcohol was considered a cause of AP when patients had a history of alcohol consumption within 48 h of symptom onset and other possible causes had been ruled out.

Smoking status was determined by whether a patient was a current smoker or did not smoke.

Insurance type was defined as whether the patient has any type of insurance; if they did not, it indicated that the patient would cover all fees.

Working hours are from 8:00 AM to 6:00 PM; other hours are non-working hours.

Seasons were classified as spring (March to May), summer (June to August), autumn (September to November), and winter (December to February).

Recovery

The "Clinical Standards for Diagnosis and Recovery Evaluation" are used to score the recovery from diseases in Chinese military hospitals (see "http://www.ed2000.com/ShowFile.asp?FileID¼512658, Article 1, Chapter 4"). For acute pancreatitis, the standard of recovery includes the resolution of abdominal symptoms; normal serum amylase and lipase levels; no complications, such as pseudocysts; and a normal pancreas based on a CT or ultrasound examination. Improved status, which can also be called "partial recovery", refers to the disappearance of symptoms of acute pancreatitis, though abdominal infection and pseudocysts remain.

Ethnics

All experiments were performed in accordance with clinical study protocols and approved by the Research Care and Ethics Committee at the Chengdu Military General Hospital. The protocol number was SCCT2011-033.

Laboratory tests

In addition to serum amylase and lipase, the following variables were collected: complete blood count without differentials, such as white cell count (WBC) and percentage of neutrophils (N%); levels of electrolytes, blood urea nitrogen (BUN), creatinine (Cr), aspartate aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and fasting blood glucose (FBG); coagulation status, including prothrombin time (PT) and activated partial prothrombin time (APTT); total albumin (Alb); and pre-albumin (pre-Alb).

Table 1. Baseline Characteristics on Admission for Acute Pancreatitis (n=684)

	N (n%)	Clinical outcomes			*P*
		Cured	Improved	Dead	
Gender, (n%)					0.517
Male	365 (53.4)	270 (74.0)	84 (23.0)	11 (3.0)	
Female	319 (46.6)	248 (77.7)	63 (19.7)	8 (2.5)	
Average age, Mean (SD)*		51.0±15.1	50.3±15.7	61.3±18.5	0.013
Age Group					0.138
≤40 y	166 (24.3)	127 (76.5)	36 (21.7)	3 (1.8)	
41-50 y	212 (30.9)	153 (72.2)	54 (25.5)	5 (2.4)	
51-60 y	114 (16.7)	96 (84.2)	16 (14.0)	2 (1.8)	
≥61 y	192 (28.1)	142 (74.0)	41 (21.4)	9 (4.7)	
Types of AP, (n%)					<0.001
Interstitial oedematous pancreatitis	556 (81.3)	456 (82.0)	93 (16.7)	7 (1.3)	
Necrotising pancreatitis	128 (18.7)	62 (48.4)	54 (42.2)	12 (9.4)	
Insurance type, (n%)					0.786
Medicare	496 (72.5)	376 (75.8)	105 (21.2)	15 (3.0)	
Self-pay	188 (27.5)	142 (75.5)	42 (22.3)	4 (2.1)	
Time of admission, (n%)					0.942
Day shift	418 (61.1)	318 (76.1)	89 (21.3)	11 (2.6)	
Night shift	266 (38.9)	200 (75.2)	58 (21.8)	8 (3.0)	
Season of admission, (n%)					0.861
Spring	160 (23.4)	125 (78.1)	31 (19.4)	4 (2.5)	
Summer	158 (23.1)	119 (75.3)	35 (22.2)	4 (2.5)	
Autumn	201 (29.3)	147 (73.1)	46 (22.9)	8 (4.0)	
Winter	165 (24.2)	127 (77.0)	35 (21.2)	3 (1.8)	
Duration before treatment, (n%)					0.323
≤24 h	253 (37.0)	195 (77.1)	48 (19.0)	10 (4.0)	
25-72 h	152 (22.2)	114 (75.0)	33 (21.7)	5 (3.3)	
≥73 h	279 (40.8)	209 (74.9)	66 (23.7)	4 (1.4)	
Residence of living, No. (N%)					0.198
City	313 (45.8)	246 (78.6)	61 (19.5)	6 (1.9)	
Rural area	371 (54.2)	272 (73.3)	86 (23.2)	13 (3.5)	
Current smoker, No. (N%)					0.807
Yes	212 (31.0)	158 (74.5)	47 (22.2)	7 (3.3)	
No	472 (69.0)	360 (76.3)	100 (21.2)	12 (2.5)	
Etiology of AP					
Biliary acute pancreatitis, (n%)					0.384
Yes	283 (41.3)	215 (76.0)	63 (22.3)	5 (1.8)	
No	401 (58.6)	303 (75.6)	84 (20.9)	14 (3.5)	
HTAP, (n%)					0.012
Yes	105 (15.4)	71 (67.6)	27 (25.7)	7 (6.7)	
No	579 (84.6)	447 (77.2)	120 (20.7)	12 (2.1)	
Alcoholic AP, (n%)					0.071
Yes	112 (16.4)	77 (68.8)	33 (29.5)	2 (1.8)	
No	572 (83.6)	441 (77.1)	114 (19.9)	17 (3.0)	
Severity score system					
APACHE II (n% within group)					<0.001
<8	488 (71.3)	393 (80.5)	90 (18.4)	5 (1.0)	
≥8	196 (28.7)	125 (63.8)	57 (29.1)	14 (7.1)	
Marshall (n% within group)					<0.001
<2	500 (73.1)	402 (80.4)	91 (18.2)	7 (1.4)	
≥2	184 (26.9)	116 (63.0)	56 (30.4)	12 (6.5)	
Ranson (n% within group)					<0.001
<3	498 (72.8)	409 (82.1)	84 (16.9)	5 (1.0)	
≥3	186 (27.2)	109 (58.6)	63 (33.9)	14 (7.5)	

*Continuous data presented as the mean ± SD and analyzed using one-way ANOVA; other categorical data were analyzed using Pearson's chi-square test.

Table 2. Baseline characteristics of plasma biochemical indexes within 48 h of admission

Variables	Median (P25, P75)			*P*
	Cured (n=518)	Improved (n=147)	Dead (n=19)	
ALP (IU/L)	98.4 (74.0, 157.4)	95.5 (70.6, 142.2)	69.7 (53.5, 123.0)	0.016
ALT (IU/L)	43.3 (21.0, 130.8)	28.9 (16.0, 69.9)	57.3 (35.2, 97.0)	0.002
APTT (s)	26.0 (23.5, 29.6)	27.3 (23.9, 32.3)	27.7 (25.3, 48.6)	0.016
AST (IU/L)	47.8 (31.4, 102.5)	52.3 (33.0, 92.0)	82.0 (60.8, 189.2)	0.009
BUN (mmol/L)	4.67 (3.46, 6.27)	5.54 (3.62, 7.11)	7.63 (4.80, 14.87)	<0.001
Cr (mmol/L)	62.6 (51.7, 78.9)	66.5 (54.4, 84.6)	79.2 (53.0, 268.0)	0.015
HDL (mmol/L)	1.2 (0.9, 1.5)	1.0 (0.7, 1.5)	1.0 (0.7, 1.9)	0.162
LDL (mmolL)	2.47 (1.92, 3.19)	2.26 (1.62, 3.12)	2.71 (1.54, 4.16)	0.167
N%	86.0 (79.5, 89.9)	87.2 (82.0, 90.9)	88.3 (86.3, 91.1)	0.018
PT (s)	12.5 (11.5, 13.6)	12.9 (11.7, 14.5)	13.8 (12.6, 15.4)	<0.001
Tbil (μmol/L)	24.0 (15.8, 38.6)	25.3 (15.8, 38.5)	26.6 (13.7, 44.5)	0.923
TCH (mmol/L)	4.3 (3.4, 5.4)	3.9 (3.1, 5.5)	4.2 (2.8, 7.5)	0.269
TG (mmol/L)	1.44 (0.88, 3.2)	1.72 (0.9, 3.7)	2.06 (1.3, 8.1)	0.181
WBC (10^9/L)	12.4 (8.6, 16.1)	13.2 (8.8, 18.4)	15.5 (11.0, 16.8)	0.036
Alb (g/L)	39.2 (32.8, 43.4)	31.9 (28.1, 39.0)	26.7 (24.1, 34.1)	<0.001
Pre-alb (g/mL)	172.0 (112.7, 246.1)	121.0 (79.9, 190.8)	108.0 (88.0, 148.0)	<0.001
Amy (U/L)	420.9 (128.5, 1164.5)	513.0 (131.6, 1128.4)	1215.4 (313.8, 2128.8)	0.064
Ca (mmol/L)	2.0 (1.9, 2.2)	1.9 (1.7, 2.1)	1.8 (1.5, 1.9)	<0.001
Hemoglobin (g/L)	128.5 (113.0, 148.2)	128.0 (105.0, 153.0)	126.0 (83.0, 150.0)	0.525
K (mmol/L)	3.8 (3.5, 4.2)	3.9 (3.6, 4.3)	4.0 (3.6, 4.2)	0.238
Na (mmol/L)	137.0 (133.8, 139.7)	135.5 (131.8, 139.8)	134.7 (130.9, 139.6)	0.026
Hematocrit (%)	39.1 (34.5, 44.5)	39.1 (32.3, 46.4)	40.1 (27.1, 44.0)	0.719
Glucose (mmol/L)	7.7 (5.9, 10.3)	8.5 (6.5, 12.6)	9.2 (7.0, 17.0)	<0.001
Lymphocyte (10^9/L)	1.0 (0.7, 1.4)	0.9 (0.6, 1.3)	0.7 (0.5, 1.7)	0.141

All variables are listed as median (p25-p75) or n (n%), followed by Kruskal-Wallis H test or Pearson's chi-square.

Statistical analysis

Recovery, partial recovery and death were regarded as the primary categorical outcomes. SPSS V19.0 (IBM, USA) was used to analyze the data. Continuous variables were expressed as the means ± standard deviations or percentages and were analyzed with one-way ANOVA for normal distributions and with the H test for abnormal distributions. Categorical data were analyzed using the chi-square test as appropriate. Multinomial logistic regression was used to identify risk factors and estimate the odds ratio (OR) of these factors. The demographic variables (age and sex) were entered into the model as covariates; other variables were included in the model one by one. For both models, P<0.05 was considered to be statistically significant.

Results

Demographic characteristics

A total of 833 consecutive patients were previewed before the clinical profiles were checked, and 684 patients were included in the final analysis (see the research flow chart). There were 365 males and 319 females in the cohort with an average age of 51.1±11.3 years. Among all AP patients, 128 (18.7%) were diagnosed with SAP and 556 (81.3%) were diagnosed with MAP and MSAP. **Table 1** shows the patients' characteristics upon admission and routine biochemical indexes within 48 h after admission and before intervention.

Primary clinical outcomes were defined as recovery, partial recovery and death. All variables were also divided into categorical subgroups.

Primary outcome rates were compared between different subgroups of each variable (**Table 1**). There were no significant differences based on sex, insurance status, place of residence, season or time of admission, or time interval before treatment. In addition, history of biliary disease, smoking and alcohol use were similar among different subgroups. The average age in the dead group was 61.3±18.5 years, which was almost 10 years older than

Table 3. Baseline characteristics of plasma biochemical indexes within 48 h of admission

Value Range	N (%)			*P*
	Cured (n=518)	Improved (n=147)	Dead (n=19)	
32-150	375 (74.0)	115 (22.7)	17 (3.4)	0.109
<32 or >150	143 (80.8)	32 (18.1)	2 (1.1)	
5-50	287 (73.2)	96 (24.5)	9 (2.3)	0.068
<5 or >50	231 (79.1)	51 (17.5)	10 (3.4)	
20-40	479 (76.8)	132 (21.2)	13 (2.1)	0.001
<20 or >40	39 (65.0)	15 (25.0)	6 (10.0)	
5-50	270 (78.5)	72 (20.9)	2 (0.6)	0.002
<5 or >50	248 (72.9)	75 (22.1)	17 (5.0)	
2.9-7.2	359 (79.6)	85 (18.8)	7 (1.6)	0.001
<2.9 or >7.2	159 (68.2)	62 (26.6)	12 (5.2)	
44-133	449 (77.4)	124 (21.4)	7 (1.2)	<0.001
<44 or >133	69 (66.3)	23 (22.1)	12 (11.5)	
0.85-2.0	372 (79.0)	90 (19.1)	9 (1.9)	0.006
<0.85 or >2.0	146 (68.5)	57 (26.8)	10 (4.7)	
1.5-3.3	345 (78.4)	87 (19.8)	8 (1.8)	0.031
<1.5 or >3.3	173 (70.9)	60 (24.6)	11 (4.5)	
40-75	85 (82.5)	18 (17.5)	0 (0.0)	0.081
<40 or >75	433 (74.5)	129 (22.2)	19 (3.3)	
9-13	339 (80.1)	78 (18.4)	6 (1.4)	0.001
<9 or >13	179 (68.6)	69 (26.4)	13 (5.0)	
5-28	304 (77.2)	81 (20.6)	9 (2.3)	0.487
<5 or >28	214 (73.8)	66 (22.8)	10 (3.4)	
2.8-5.7	361 (79.2)	87 (19.1)	8 (1.8)	0.004
<2.8 or >5.7	157 (68.9)	60 (26.3)	11 (4.8)	
0.29-1.83	304 (77.2)	82 (20.8)	8 (2.0)	0.314
<0.29 or >1.83	214 (73.8)	65 (22.4)	11 (3.8)	
3.5-9.5	148 (78.8)	39 (20.7)	1 (0.5)	0.079
<3.5 or >9.5	370 (74.6)	108 (21.8)	18 (3.6)	
32-55	409 (84.2)	72 (14.8)	5 (1.0)	<0.001
<32 or >55	109 (55.1)	75 (37.9)	14 (7.1)	
180-390	231 (84.6)	42 (15.4)	0 (0.0)	<0.001
<180 or >390	287 (69.8)	105 (25.5)	19 (4.6)	
25-125	122 (77.7)	33 (21.0)	2 (1.3)	0.410
<25 or >125	396 (75.1)	114 (21.6)	17 (3.2)	
2-2.7	306 (84.1)	55 (15.1)	3 (0.8)	<0.001
<2 or >2.7	212 (66.3)	92 (28.8)	16 (5.0)	
115-150	234 (75.3)	68 (21.0)	5 (3.7)	0.249
<115 or >150	284 (76.2)	79 (22.1)	14 (1.6)	
3.5-5.5	392 (75.8)	110 (21.3)	15 (2.9)	0.921
<3.5 or >5.5	126 (75.4)	37 (22.2)	4 (2.4)	
132-150	447 (79.0)	107 (18.9)	12 (2.1)	<0.001
<132 or >150	71 (60.2)	40 (33.9)	7 (5.9)	
38-51	260 (76.9)	70 (20.7)	8 (2.4)	0.697
<38 or >51	258 (74.6)	77 (22.3)	11 (3.2)	
3.8-6.1	137 (84.0)	25 (15.3)	1 (0.6)	0.009
<3.8 or >6.1	381 (73.1)	122 (23.4)	18 (3.5)	
1.1-3.2	192 (78.0)	47 (19.1)	7 (2.8)	0.523
<1.1 or >3.2	326 (74.4)	100 (22.8)	12 (2.7)	

All variables are listed as median (p25-p75) or n (n%), followed by Pearson's chi-square.

that of other groups (P=0.013). The classification of AP (MAP, MSAP or SAP) and etiology of AP (HTAP or not) were also significantly different be tween subgroups (P<0.001 and P= 0.012, respectively). Severity scores, including APACHEII, Ranson and Marshall [16-20], were significantly different among the three outcome groups (P<0.001).

Baseline data of plasma biochemical indexes

Routine experimental tests were carried out at admission on all patients included in the study. Plasma biochemical variables (taken within 48 h) of the three outcome groups were compared at baseline (**Table 2**). Each blood variable was divided into two subgroups-normal range and abnormal range-according to the clinical reference range. The Kruskal-Wallis H test was used to compare the medians and percentages of each variable among the three groups.

For the variables we observed, ALP, AST, ALT, APTT, BUN, Cr, N%, PT, WBC, and FBG levels were the highest in the dead group compared to the recovery and partially recovery groups. Subjects in the dead group had the lowest levels of Alb, pre-Alb, Ca^{2+}, and Na^{+}.

When the variables were divided into two levels according to the reference range, we found that levels of AST, Cr, LDL, Tch, Alb, pre-Alb, Ca^{2+}, Na^{+} and blood glucose in each subgroup were significantly different (see **Table 3**, all P<0.001).

Risk factors of clinical outcomes

A step-wise backward logistic regression analysis was conducted to determine which factors were related to the outcomes of AP patients (**Table 4**). Using the recovery group as the reference, risk factors for death and improvement are listed in **Table 4**. Patients over 61 years of age had a 5-fold greater risk of dying than did patients younger than 40 (P=0.026,

Table 4. Risk factors for dead and improved groups using multinomial logistic regression (cured group as reference)

		Dead group (n=581)		Improved group (n=147)	
		OR (95% CI)	*P*	OR (95% CI)	*P*
Gender	Female	1		1	
	Male	1.323 (0.481, 3.639)	0.588	1.056 (0.695, 1.606)	0.797
Age group	≤40 y	1		1	
	41-50 y	1.325 (0.305, 5.760)	0.707	1.186 (0.729, 1.932)	0.492
	51-60 y	1.323 (0.209, 8.370)	0.766	0.587 (0.304, 1.134)	0.113
	≥61 y	5.086 (1.210, 21.373)	0.026	1.094 (0.637, 1.879)	0.745
Diagnosis	Interstitial edematous pancreatitis	1		1	
	necrotizing pancreatitis	7.023 (2.317, 21.288)	0.001	2.934 (1.842, 4.671)	<0.001
Cr	Normal range	1		1	
	Abnormal	7.259 (2.442, 21.575)	<0.001	0.824 (0.469, 1.449)	0.501
Alb	Normal range	1		1	
	Abnormal	3.389 (1.032, 11.130)	0.044	3.040 (1.992, 4.639)	<0.001
AST	Normal range	1		1	
	Abnormal	11.345 (2.355, 54.651)	0.002	0.900 (0.597, 1.355)	0.612
Alcoholic AP	No	1		1	
	Yes	0.537 (0.119, 2.418)	0.418	1.678 (1.052, 2.676)	0.030
HTAP	No	1		1	
	Yes	3.364 (1.237, 9.144)	0.017	1.427 (0.862, 2.362)	0.167

OR: 5.086, 95% CI=1.210-21.373). SAP patients had a greater risk of death than did MAP and MSAP patients (P=0.001, OR: 7.023, 95% CI=2.317-21.288). Those diagnosed with HTAP also had a higher mortality risk (P=0.017, OR: 3.364, 95% CI=1.237-9.144). In addition, the adjusted odds ratios for Cr, Alb and AST were 7.259 (95% CI=2.442-21.575); 3.389 (95% CI=1.032-11.130); and 11.345 (95% CI=2.355-54.651), respectively, all of which had *P* values below 0.05.

MAP and MSAP patients had a greater chance for improvement than SAP patients (P<0.001, OR: 2.934, 95% CI=1.842-4.671). In addition, Alb had an impact on disease recovery. Patients whose blood Alb level was abnormal at admission had less chance of improvement than those who had normal Alb levels (P<0.001, OR: 3.040, 95% CI=1.992, 4.639). Patients who were not diagnosed with alcoholic AP were more likely to improve (P=0.030, OR: 1.678, 95% CI=1.052, 2.676).

Discussion

Our department, the Center for Pancreatic Research, treats an average of 300 AP patients annually. Based on new surgical techniques for AP treatment, we have published a series of papers in recent years [21-23]. However, a full understanding of AP patients and the factors associated with clinical outcomes is far beyond our knowledge. In this study, we found that age was the only demographic factor with a relation to the outcome of AP patients, and on-admission indices, such as Cr, AST and Alb, were related to the patients' prognosis. The etiology of HTAP and the AP severity classification were also risk factors for mortality. Alcoholic AP, severity diagnosis and blood Alb level were risk factors for poor improvement. Variables that we had hypothesized to be meaningful in predicting the outcomes, such as place of residence, smoking, drinking, and time and season of admission, did not show significant relationships with the outcomes of AP patients.

Among all the risk factors that have been reported, age is undoubtedly an important one that cannot be ignored. In our multivariate analysis, patients over 61 years of age had the highest risk for mortality. In accordance with our result, a review by the AGA Institute Governing Board confirmed that age is a predictive factor for mortality in acute pancreatitis [24]. Additionally, we found that HTAP is also related to mortality. Patients diagnosed with HTAP had a more than 3-fold higher risk of dying. Although gallstones represent the most frequent etiology of acute pancreatitis in many reports worldwide (it is estimated that between 40% and 60% of

acute pancreatitis cases include gallstones), in most cases, gallstone pancreatitis is a mild and self-limiting disease, and patients without complications may be treated with a cholecystectomy to prevent future recurrence [25]. In our study, 41.3% of all AP patients had gallstones, 15.4% were diagnosed with HTAP, and 16.4% were diagnosed with alcoholic AP. These results are similar to the multicenter study on the etiology of acute pancreatitis in Beijing by Zheng *et al*. that classified the diagnoses as biliary (1372, 55.75%), alcoholism (246, 10%), hypertriglyceridemia (255, 10.36%), and other (588, 23.89%) [26]. The mortality rate in the HTAP group was almost 4 times higher than that in the other groups. Although the mortality rate varied among the three AP groups of different etiologies, hypertriglyceridemic acute pancreatitis is often reported to relapse, and its clinical course is more severe than that of lithiasic acute pancreatitis [27].

Total albumin and pre-albumin are the most frequently and commonly used indices in clinics for screening and evaluating patient malnutrition. In 1989, Phillips et al. discussed the association between serum albumin and mortality from cardiovascular disease, cancer, and other causes. Later, the relationship between a lower albumin level and a higher mortality rate was widely explored in healthy and sick elderly subjects [29-31]. For AP, the blood Alb level was associated with severity in children [32], but the relationship between blood Alb level and adult AP mortality is still unknown. Our study results suggest that not only Alb but also pre-Alb levels are significantly related to mortality.

An abnormal creatinine level was considered to predict a more severe or adverse clinical course of AP, including a higher mortality rate [31, 33, 34]. The abnormal creatinine concentration may represent mild to severe kidney dysfunction, which could be indicative of disease severity. Similarly, an abnormal AST level, although it may not be high enough to indicate liver dysfunction in AP, is also a marker for hepatic lesions. Moreover, AST is included in the Ranson scoring system, which means it is an index for evaluating the severity of disease.

Limitations of this study

The limitations of our study include missing patient data, which is a general limitation of retrospective cohort studies. All patients in this study were from a single center, which may not be representative of the full scope of AP cases. In addition, none of the possible mechanisms for treating AP were explored in this study. We could only explore the relationship between the outcome of AP patients and certain risk factors.

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Disclosure of conflict of interest

None.

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