Journal of Pediatric Surgery (2011) **46**, 1144–1149

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Journal of Pediatric Surgery

www.elsevier.com/locate/jpedsurg

Acute pancreatitis in children: spectrum of disease and predictors of severity

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Received 12 March 2011; accepted 26 March 2011

Key words:
Pancreatitis;
Acute;
Pediatric;
Children;
Adolescents;
Severity;
Ranson;
Modified Glasgow

Abstract

Background: The aim of this study was to describe the spectrum of disease in children with acute pancreatitis and assess predictors of severity.

Methods: Children (≤18 years) admitted to a single institution with acute pancreatitis from 2000 to 2009 were included. The accuracy of the Ranson, modified Glasgow, and pediatric acute pancreatitis severity (PAPS) scoring systems for predicting major complications was assessed.

Results: The etiology of pancreatitis in these 211 children was idiopathic (31.3%), medication-induced (19.9%), gallstones (11.8%), trauma (7.6%), transplantation (7.6%), structural (5.2%), and hemolytic-uremic syndrome (3.3%). Fifty-six patients (26.5%) developed severe complications. Using the cutoff thresholds in the PAPS scoring system, only admission white blood cell count more than 18,500/μL (odds ratio [OR], 3.1; $P = .010$), trough calcium less than 8.3 mg/dL (OR, 3.0; $P = .019$), and blood urea nitrogen rise greater than 5 mg/dL (OR, 4.1; $P = .004$) were independent predictors of severe outcome in a logistic regression model. The sensitivity (51.8%, 51.8%, 48.2%) and negative predictive value (83.2%, 83.5%, 80.5%) of the Ranson, modified Glasgow, and PAPS scores were, respectively, insufficient to guide clinical decision making.

Conclusion: Commonly used scoring systems have limited ability to predict disease severity in children and adolescents with acute pancreatitis. Careful and repeated evaluations are essential in managing these patients who may develop major complications without early signs.

Pancreatitis is a significant cause of morbidity in the pediatric population. The incidence of pancreatitis in the pediatric age group has increased significantly in the past 2 decades. It is estimated that 2 to 13 new cases occur annually per 100,000 children [1]. Nearly a quarter of children with acute pancreatitis develop a severe complication, and the mortality rate is approximately 4% despite significant advances in the treatment of this disease [2].

In large part, our understanding of the pathology, optimal management, and outcome of pancreatitis in children is extrapolated from the adult literature. Beginning with the study of Ranson et al [3] in 1974, several clinical and radiologic systems for predicting disease severity have been studied in adults [4-6]. These scoring systems may facilitate early identification of patients at high risk for significant morbidity to expedite intensification of care. Combined with emerging evidence-based approaches to the selection and

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0022-3468/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.jpedsurg.2011.03.044

timing of antibiotics, route of nutrition, and critical care management, this prognostic information has helped reduce morbidity and mortality in adult pancreatitis [7-10].

The applicability of adult data to the pediatric population should be questioned because etiologies, comorbidities, and outcomes are quite different in children. In an effort to address the unique features of acute pancreatitis in children, DeBanto et al [2] formulated the pediatric acute pancreatitis severity (PAPS) score. The PAPS score, which includes weight-based and age-appropriate metrics, was reported to have a sensitivity of 70% and a negative predictive value of 91% in the pediatric population [2]. A subsequent analysis of Japanese children, however, reported equivalent sensitivity using the PAPS or the Ranson scoring systems (60% each) [11]. The purpose of our study was to evaluate the predictive value of the Ranson, modified Glasgow, and PAPS scoring systems in the pediatric population to determine their utility in clinical practice.

1. Methods

1.1. Data collection

The records of all children and adolescents (<18 years of age) treated for acute pancreatitis at our institution from 2000 through 2009 were reviewed. The study was approved by the hospital's institutional review board (#2009-13748). Analysis was limited to inpatient encounters and to the first encounter in patients with more than one admission for acute pancreatitis. Patients were identified by searching the hospital's electronic discharge records for the *International Classification of Disease, Ninth Revision* (*ICD-9*) code 577.0 (acute pancreatitis). All diagnoses were manually confirmed by review of admission histories, laboratory values, and imaging findings.

Additional demographic, clinical, and radiologic variables collected included age, sex, etiology of pancreatitis (as documented by the treating physicians), medical comorbidities, and surgical procedures. Outcome variables including the development of complications, readmissions, and mortality were recorded.

1.2. Disease severity

Patients were stratified into those having mild and severe outcome using methodology similar to that used by DeBanto et al [2]. Criteria for severe disease included mortality, surgery on the pancreas, acute renal failure, respiratory failure, severe gastrointestinal bleed, or shock during the initial admission and/or subsequent pseudocyst development. Surgery on the pancreas was identified by *ICD-9* procedure codes for pancreatic biopsy or aspiration (52.11-52.12), percutaneous pseudocyst drainage (52.01), cystgastrostomy or cystenterostomy (52.4), pancreatectomy, partial or complete (52.5-52.7), and other pancreatic operations including repair or duct drainage (52.95, 52.96, 52.99). Acute renal failure was identified by *ICD-9* code 584.5 or 584.9 or by creatinine rise greater than 2 mg/dL. Acute respiratory failure was identified by *ICD-9* codes 518.0, 518.81, and 518.82 or Pao_2 less than 60 mm Hg. Shock was defined as the need for vasopressor medication (epinephrine, norepinephrine, or dopamine). Pseudocyst development was identified by *ICD-9* code 577.2 and confirmed by review of imaging.

1.3. Predictors of outcome

Clinical parameters compared between patients with mild and severe disease included age, sex, admission amylase level, admission lipase level, necrosis on admission contrast-enhanced computed tomography (CT) scan, etiology of pancreatitis, and medical comorbidities. Evidence of necrosis on CT was obtained from the imaging reports for studies performed within the first 72 hours of admission. Etiology of pancreatitis was stratified into gallstone, medication-induced, structural (choledochal cyst, annular pancreas, pancreas divisum), traumatic, posttransplant, hypertriglyceridemia, hemolytic-uremic syndrome, other, or idiopathic. Medical comorbidities studied included leukemia, other malignancy, epilepsy, cystic fibrosis, inflammatory bowel disease, and autoimmune disease (systemic lupus erythematosus or juvenile rheumatoid arthritis).

1.4. Clinical scoring systems

The clinical and laboratory factors used in the Ranson, modified Glasgow, and PAPS systems were compared between patients with mild and severe disease. Laboratory values drawn and imaging performed at other institutions within 12 hours of admission were included in the analysis. Laboratory values drawn within the second full day of the encounter were included in the 48-hour analysis regardless of the exact hour drawn. Parameters were compared using continuous values, as well as using the cutoff values proposed in each scoring system. A logistic regression model was created to identify which of the PAPS parameters were independent predictors of outcome. Finally, using a score of 3 or more positive parameters as a positive result, the sensitivity, specificity, negative predictive value, and positive predictive value of each scoring system was assessed.

1.5. Statistical analysis

Outcomes of interest were compared by χ^2 test for categorical data and Student t test for continuous data. A logistic regression model was used to identify independent predictors of disease severity. All parameters in the PAPS scoring system with $P < .05$ in univariate analysis were

entered into the regression model. All P values were 2-tailed, and $P < .05$ was considered significant. Statistical analyses were performed using XenoBase Bio-Integration Suite (TransMed Systems, Cupertino, CA) and SPSS, version 18 (SPSS Corporation, Chicago, IL).

2. Results

There were 211 patients (52% male) admitted for acute pancreatitis between 2000 and 2009. The mean age at diagnosis was 10.94 ± 4.88 years. Comorbidities included malignancy (41.2%; including leukemia in 18%), epilepsy (10.4%), autoimmune disease (2.8%), and inflammatory bowel disease (1.9%). Eight patients (3.4%) had a prior history of chronic pancreatitis. Mean amylase and lipase levels on admission were 726.8 ± 46.8 IU/L and 1680.3 ± 189.9 U/L, respectively. Admission amylase was greater than twice normal in 151 (71.6%) patients, whereas lipase was greater than 2 times normal in 190 (90.0%) patients.

2.1. Etiology

Table 1 summarizes the causes of pancreatitis in our patient population. The most common etiology was idiopathic (31.1%). Pancreatitis was precipitated by a medication in 19.9%, including asparaginase in 10.9% and valproic acid in 3.8%. Gallstone pancreatitis occurred in 11.8%, whereas the disease followed trauma or transplant in 7.6% each.

2.2. Outcome

During the initial admission, 61 (28.9%) patients required transfer to the pediatric intensive care unit.

Table 1 Etiology of acute pancreatitis

	Frequency (%)
Medication	42 (19.9)
Asparaginase	23 (10.9)
Depakote	8 (3.8)
Gallstone	25 (11.8)
Structural [a]	11 (5.2)
Trauma	16 (7.6)
Posttransplant	16 (7.6)
Diabetic ketoacidosis	9 (4.3)
Hemolytic-uremic syndrome	7 (3.3)
Hypertriglyceridemia	4 (1.9)
Familial/hereditary	2 (0.9)
Other [b]	13 (6.2)
Idiopathic	66 (31.3)

[a] Choledochal cyst, pancreas divisum, and annular pancreas.
[b] Alcohol (1), autoimmune (3), cystic fibrosis (2), post–cardiac surgery (2), sepsis (1), post-ERCP (3), and viral (1).

Table 2 Criteria for severe pancreatitis

Criterion	Frequency (%)
One or more of the following	56 (26.5)
Respiratory failure	25 (11.8)
Acute renal failure	23 (10.9)
Pseudocyst	22 (10.4)
Shock	6 (2.8)
Operation on pancreas	5 (2.4)
Gastrointestinal Bleed	2 (0.9)
In-hospital mortality	5 (2.4)

Parenteral nutrition was administered to 68 patients (32.2%). Fourteen patients (6.6%) required a procedure on the pancreas. Twenty-six (12.3%) children required subsequent readmission for acute pancreatitis, and 32 (15.2%) developed chronic pancreatitis. Using the criteria proposed by DeBanto et al [2], 56 (26.5%) patients had major complications and were considered to have severe disease (Table 2). This included 5 (2.4%) patients who died during their initial pancreatitis hospitalization. No deaths were directly attributable to pancreatitis; all were related to severe underlying comorbidities.

2.3. Predictors of outcome

Admission features, medical comorbidities, and etiologies for patients with mild and severe disease are compared in Table 3. Admission amylase ($P = .900$) and lipase ($P = .118$) levels did not correlate with outcome. Pancreatic necrosis on contrast-enhanced CT scan was associated with significantly higher rates of severe disease (42.3%) compared with patients who underwent a CT scan showing no evidence of necrosis (10.5%; $P = .002$). Of the medical comorbidities investigated, only epilepsy was associated with severe disease ($P = .008$). Likewise, hemolytic-uremic syndrome ($P = .006$), and prior transplantation ($P = .027$) were associated with severe disease, but other etiologies of pancreatitis were not correlated with outcome.

The Ranson, modified Glasgow, and PAPS scoring systems are based on several clinical and laboratory parameters. Table 4 compares the mean values of these parameters in patients having mild vs severe pancreatitis. Patients with severe disease presented at an older age (12.41 ± 0.61 years) than those with mild disease (10.39 ± 0.40 years; $P = .008$). Admission weight was greater in patients with severe disease, although this finding did not reach statistical significance ($P = .107$). There was no difference in fluid sequestration (in milliliters per kilogram; in the first 48 hours) or 48-hour peak base deficit, although the latter parameter was only assessed in a small number of patients. All other laboratory values correlated significantly with disease severity in univariate analysis, including white blood cell count (WBC; $P < .001$), glucose ($P = .028$), lactate dehydrogenase (LDH; $P = .038$), and aspartate aminotransferase ($P = .012$) on admission, as well as hematocrit drop

Table 3 Admission findings, comorbidities, and etiologies by disease severity

	Mild outcome (n = 155)	Severe outcome (n = 56)	*P*
Admission findings			
Amylase (IU/L)	719.4 ± 54.8	706.4 ± 82.6	.900
Lipase (U/L)	1761.0 ± 211.3	1147.8 ± 278.0	.118
Necrosis on CT scan	6/57 (10.5%)	11/26 (42.3%)	.002
Medical comorbidities			
Leukemia	30 (19.4%)	8 (14.3%)	.397
Other malignancies	32 (20.6%)	17 (30.4%)	.140
Epilepsy	11 (7.1%)	11 (19.6%)	.008
Cystic fibrosis	1 (0.6%)	1 (1.8%)	.450
Inflammatory bowel disease	4 (2.6%)	0	.225
Autoimmune disease	4 (2.6%)	2 (3.4%)	.702
Etiology of pancreatitis			
Gallstone	20 (12.9%)	5 (8.9%)	.430
Medication	32 (20.6%)	10 (17.9%)	.654
Structural	9 (5.8%)	2 (3.6%)	.519
Trauma	13 (8.4%)	3 (5.4%)	.463
Posttransplant	8 (5.2%)	8 (14.3%)	.027
Hemolytic-uremic syndrome	2 (1.3%)	5 (8.9%)	.006
Idiopathic	53 (34.2%)	13 (23.2%)	.129
All other	18 (11.6%)	10 (17.9%)	.254

($P < .001$), trough calcium ($P < .001$), trough albumin ($P < .001$), trough arterial Po_2 ($P = .002$), and rise in blood urea nitrogen (BUN; $P < .001$) at 48 hours.

2.4. PAPS cutoff values

Although the mean values of the aforementioned clinical and laboratory parameters differ significantly between patients having mild and severe outcomes, the application of these findings to clinical practice is based on cutoff values for each factor. The Ranson, modified Glasgow, and PAPS scores are all determined by the number of clinical and laboratory parameters above or below a predetermined cutoff threshold. When the cutoff values proposed in the PAPS scoring system were applied to our patient population, factors that predicted severe vs mild disease by χ^2 test included the following: admission WBC more than 18,500/μL (38.2% vs 12.9%, $P < .001$), trough calcium less than 8.3 mg/dL (75.5% vs 32.2%, $P < .001$), trough albumin less than 2.6 g/dL (58.2% vs 22.8%, $P < .001$), and BUN rise greater than 5 mg/dL (37.0% vs 6.8%, $P < .001$). Other PAPS criteria including weight lower than 23 kg (20.0% vs 26.8%, $P = .318$), LDH greater than 2000 IU/L (30.0% vs 5.9%, $P = .088$), and fluid sequestration greater than 75 mL kg^{-1} 48 h^{-1} (29.6% vs 25.0%, $P = .630$) did not reach significance. In contrast to the original PAPS report, patients younger than 7 year were actually more likely to have mild (29.0%) than severe (12.5%, $P = .014$) disease [2].

2.5. Logistic regression

All clinical parameters with $P < .05$ by χ^2 test (using the PAPS cutoff thresholds) were entered into a logistic regression model to determine independent predictors of outcome. In this model, WBC greater than 18,500/μL (odds ratio [OR], 3.1; $P = .010$), calcium less than 8.3 mg/dL (OR, 3.0; $P = .019$), and BUN rise higher than 5 mg/dL (OR, 4.1; $P = .004$) were independent predictors of severe outcome. In contrast, age greater than 7 years ($P = .112$) and albumin less than 2.6 g/dL ($P = .124$) were not significant independent predictors of outcome.

2.5.1. Scoring system performance

The cutoff criteria proposed in the Ranson, modified Glasgow, and PAPS scoring systems were applied to each patient, and a total score was calculated by counting the number of positive criteria. Patients with severe disease had a

Table 4 Clinical and laboratory parameters

Parameter	Mild outcome		Severe outcome		*P*
	Mean ± SEM	n	Mean ± SEM	n	
Admission age (y)	10.39 ± 0.40	154	12.41 ± 0.61	56	.008
Admission weight (kg)	41.6 ± 1.8	154	47.7 ± 3.7	55	.107
Admission WBC (thousand/μL)	11.2 ± 0.6	146	16.5 ± 1.6	55	<.001
Admission glucose (mg/dL)	129.4 ± 7.6	149	172.9 ± 25.1	54	.028
Admission LDH (IU/L)	473.1 ± 135.2	18	1732.4 ± 746.1	10	.038
Admission AST (IU/L)	84.0 ± 8.9	143	189.0 ± 64.5	52	.012
48-h change in Hct (%)	8.0 ± 0.9	139	16.0 ± 2.4	54	<.001
48-h peak base deficit	17.0	1	9.1 ± 2.3	11	.336
48-h trough calcium (mg/dL)	8.7 ± 0.1	145	7.7 ± 0.1	53	<.001
48-h trough albumin (mg/dL)	3.3 ± 0.1	145	2.7 ± 0.1	55	<.001
48-h trough Po_2 (mm Hg)	85.5 ± 5.7	7	57.4 ± 4.4	21	.002
48-h fluid sequestration (mL kg^{-1} 48 h^{-1})	49.5 ± 4.0	95	49.0 ± 12.8	27	.959
48-h change in BUN (mg/dL)	1.5 ± 0.4	145	8.5 ± 2.5	54	<.001

AST indicates aspartate aminotransferase; Hct, hematocrit.

Table 5 Performance of the PAPS, Ranson, and modified Glasgow scoring systems

	PAPS		Ranson		Modified Glasgow	
	Mild	Severe	Mild	Severe	Mild	Severe
Mean ± SEM score	1.4 ± 0.1	2.5 ± 0.2	0.9 ± 0.1	2.8 ± 0.3	1.0 ± 0.1	2.8 ± 0.2
Score <3 (n)	120	29	134	27	137	27
Score ≥ 3 (n)	35	27	21	29	18	29
Accuracy	69.7%		77.3%		78.7%	
Sensitivity	48.2%		51.8%		51.8%	
Specificity	77.4%		86.5%		88.4%	
Positive predictive value	43.5%		58.0%		61.7%	
Negative predictive value	80.5%		83.2%		83.5%	

higher mean score (number of positive parameters) than those with mild pancreatitis for all 3 systems: Ranson (2.8 ± 0.3 vs 0.9 ± 0.1), modified Glasgow (2.8 ± 0.2 vs 1.0 ± 0.1), and PAPS (2.5 ± 0.2 vs 1.4 ± 0.1). For each scoring system, a score of 3 or more positive criteria is designed to predict severe disease. Using this cutoff, the Ranson, modified Glasgow, and PAPS scoring systems had a sensitivity of 51.8%, 51.8%, and 48.2%, respectively. The negative predictive value was 83.2%, 83.5%, and 80.5%, respectively (Table 5).

3. Discussion

Analysis of 211 children and adolescents treated for acute pancreatitis during the past decade illustrates the challenges and limitations of risk stratification in this heterogeneous patient population. Our study represents the largest independent comparison of the PAPS, Ranson, and modified Glasgow scoring systems. In our cohort, neither the sensitivity (48.2%) nor the negative predictive value (80.5%) of the PAPS system was as high as initially reported by DeBanto et al [2], and it fared no better than the Ranson (sensitivity, 51.8%; negative predictive value, 83.2%) or modified Glasgow (sensitivity, 51.8%; negative predictive value, 83.5%) scoring systems. Children presenting with acute pancreatitis cannot be accurately risk stratified using basic clinical and laboratory parameters from the first 48 hours of hospital admission.

Since the initial work of Ranson et al [3] in 1974, there have been extensive efforts aimed at predicting which patients with acute pancreatitis will develop major complications [6,12]. In developing the PAPS scoring system, DeBanto et al [2] appropriately recognized the significant differences in clinical presentation and etiology of pancreatitis between children and adults. The study of DeBanto et al was a multi-institutional retrospective study with an independent cohort for validation. The authors reasoned that the sensitivity and negative predictive value of the test were of highest importance in clinical practice to ensure early recognition of all patients who will develop severe disease (sensitivity) and permit routine ward admission for patients with minimal risk (negative predictive value). In their study, negative predictive value was more than 90% for all of the scoring systems (PAPS, Ranson, or modified Glasgow), but sensitivity was significantly higher in the PAPS (67%) compared with the Ranson (33%) or modified Glasgow (25%) systems. Suzuki et al [11] subsequently assessed the performance of this system in Japanese children who had a much higher rate of congenital hepatobiliary anomalies as the cause of pancreatitis (56.3%) and a lower rate of severe disease (7.4%). In their population, the PAPS system had no better sensitivity (60%) than the Ranson (60%) or modified Glasgow (40%) system. In our cohort, the sensitivity of the PAPS score was lower (48%) and was no higher than the Ranson (51.8%) or modified Glasgow (51.8%) system.

Better methods are needed to identify children at high risk for severe morbidity. The significant differences in the mean values of several clinical and laboratory parameters between children who have mild and severe disease would suggest that accurate risk stratification should be possible. However, assigning scoring system points based on cutoff thresholds for these parameters is challenging because the results are widely distributed, and there is significant overlap between patients with mild and severe outcomes. Nonetheless, our logistic regression model identified 3 parameters that corresponded independently with outcome. It comes as no surprise that these 3 factors—admission WBC, trough calcium, and BUN rise—appear in all 3 of the clinical scoring systems. Future efforts to devise a better clinical scoring system may benefit from focusing on these parameters. However, other methods of risk stratification also require investigation. The CT severity index has proven very useful in adults [4]. Although our study did not evaluate the performance of the formal CT severity index in children, we did find that patients with necrosis noted on CT scan were significantly more likely to develop severe disease. Future efforts to assess the value of the CT scoring system in children and adolescents are ongoing.

Our cohort also illustrates recent changes in the etiology of acute pancreatitis in children. In a 1996 review of the literature, the most frequent causes of pancreatitis were identified as idiopathic (22%), trauma (20%), infectious (15%), biliary tract disease (14%), drugs (13%), miscellaneous (11%), and congenital anomalies (5%) [13]. We found

comparable rates of biliary tract disease (11.8%) and congenital anomalies (5.2%) but a greater percentage of idiopathic (31.3%) and drug-related (19.9%) disease and lower rates of trauma (7.6%) and infection (<1%). The significant drop in infection-induced pancreatitis is largely caused by vaccination against the mumps virus. However, other viruses may go unrecognized as the cause of pancreatitis and explain the higher rate of idiopathic disease. The relatively high rate of drug-related pancreatitis in our study may reflect the frequent use of asparaginase at our institution, which has a high volume of oncology care. Used in the treatment of acute lymphoblastic leukemia, asparaginase is reported to cause pancreatitis in 7% of children [14]. Although long-term complications of asparaginase-induced pancreatitis are rare, recurrence occurs frequently if the drug is readministered.

This study does have several limitations inherent in any retrospective study. Clinical and laboratory values used in the scoring system were not universally available for all patients. Determining the exact start time for the 48-hour window to evaluate the clinical parameters was difficult, especially for patients transferred from other institutions and those who developed pancreatitis midway during a hospitalization. Leeway was given to include values drawn at other institutions up to 12 hours before admission and for those drawn within a few hours after the close of the 48-hour window. The high rate of severe disease in patients who have had a transplant and those with hemolytic-uremic syndrome may represent renal injury inherent to the underlying etiology and may not truly reflect the severity of pancreatitis. Finally, there may be some selection bias because our sample included a disproportionate number of oncology patients, including many with pancreatitis induced by asparaginase.

A quarter of children and adolescents with acute pancreatitis develop one or more severe complications. Unfortunately, existing scoring systems lack the predictive value needed to guide confident clinical decision making. Efforts to refine these systems should focus on the subset of parameters—admission WBC, 48-hour trough calcium, and 48-hour rise in BUN—which are independent predictors of outcome by logistic regression. Other modalities, including the CT severity index, should also be investigated to develop better models for risk stratifying children and adolescents with acute pancreatitis.

References

[1] Morinville VD, Barmada MM, Lowe ME. Increasing incidence of acute pancreatitis at an American pediatric tertiary care center: is greater awareness among physicians responsible? Pancreas 2010;39:5-8.

[2] DeBanto JR, Goday PS, Pedroso MR, et al. Acute pancreatitis in children. Am J Gastroenterol 2002;97:1726-31.

[3] Ranson JH, Rifkind KM, Roses DF, et al. Prognostic signs and the role of operative management in acute pancreatitis. Surg Gynecol Obstet 1974;139:69-81.

[4] Balthazar EJ. Acute pancreatitis: assessment of severity with clinical and CT evaluation. Radiology 2002;223:603-13.

[5] Leung TK, Lee CM, Lin SY, et al. Balthazar computed tomography severity index is superior to Ranson criteria and APACHE II scoring system in predicting acute pancreatitis outcome. World J Gastroenterol 2005;11:6049-52.

[6] Blamey SL, Imrie CW, O'Neill J, et al. Prognostic factors in acute pancreatitis. Gut 1984;25:1340-6.

[7] Al-Omran M, Albalawi ZH, Tashkandi MF, et al. Enteral versus parenteral nutrition for acute pancreatitis. Cochrane Database Syst Rev 2010;20:CD002837.

[8] Ayub K, Slavin J, Imada R. Endoscopic retrograde cholangiopancreatography in gallstone-associated acute pancreatitis. Cochrane Database Syst Rev 2010;20:CD003630.

[9] Dellinger EP, Tellado JM, Soto NE, et al. Early antibiotic treatment for severe acute necrotizing pancreatitis: a randomized, double-blind, placebo-controlled study. Ann Surg 2007;245:674-83.

[10] Heinrich S, Schafer M, Rousson V, et al. Evidence-based treatment of acute pancreatitis: a look at established paradigms. Ann Surg 2006;243:154-68.

[11] Suzuki M, Fujii T, Takahiro K, et al. Scoring system for the severity of acute pancreatitis in children. Pancreas 2008;37:222-3.

[12] Chatzicostas C, Roussomoustakaki M, Vlachonikolis IG, et al. Comparison of Ranson, APACHE II and APACHE III scoring systems in acute pancreatitis. Pancreas 2002;25:331-5.

[13] Lerner A, Branski D, Lebenthal E. Pancreatic diseases in children. Pediatr Clin North Am 1996;43:125-56.

[14] Kearney SL, Dahlberg SE, Levy DE, et al. Clinical course and outcome in children with acute lymphoblastic leukemia and asparaginase-associated pancreatitis. Pediatr Blood Cancer 2009;53:162-7.