

RAPID COMMUNICATION

## Clinical characteristics and prognostic factors of splenic abscess: A review of 67 cases in a single medical center of Taiwan

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### Abstract

**AIM:** To analyze 67 cases of splenic abscess in a medical center of Taiwan during a period of 19 years.

**METHODS:** From January 1986 to December 2004, a total of 67 patients with splenic abscess were enrolled for the retrospective study. The clinical characteristics, underlying diseases, organism spectra, therapeutic methods, APACHE II scores, and mortality rates were analyzed.

**RESULTS:** There were 41 males and 26 females with the mean age of  $54.1 \pm 14.1$  years. Multiple splenic abscesses (MSA) account for 28.4% and solitary splenic abscess in 71.6% of the patients. Twenty-six of sixty-seven patients (35.8%) had extrasplenic abscesses, with leading site of liver (34.6%). Microbiological cultures were positive in 58 patients (86.6%), with 71.8% in blood culture and 93.5% in abscess culture. Gram negative bacillus (GNB) infection predominated (55.2%), with leading pathogen of *Klebsiella pneumoniae* (22.4%), followed by gram positive coccus (GPC) infection (31%). Splenectomy was performed in 26 patients (38.8%), percutaneous drainage or aspiration in 21 (31.3%), and antibiotic therapy alone in 20 patients (29.9%). Eventually, 12 of 67 patients expired (17.9%). By statistics, spleen infected with GNB was likely to develop multiple abscesses compared with infection with GPC ( $P=0.036$ ). Patients with GNB infection ( $P=0.009$ ) and

multiple abscesses ( $P=0.011$ ) experienced a higher mortality rate than patients with GPC infection and solitary abscess. The mean APACHE II score of 12 expired patients ( $16.3 \pm 3.2$ ) was significantly higher than that of the 55 survivals ( $7.2 \pm 3.8$ ) ( $P < 0.001$ ).

**CONCLUSION:** MSA, GNB infection, and high APACHE II scores are poor prognostic factors. Early surgical intervention should be encouraged when these risk factors are present.

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**Key words:** Splenic abscess; Prognosis; Gram negative bacillus infection; APACHE II scores

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### INTRODUCTION

Splenic abscess is a rare entity, with a reported frequency in autopsy series between 0.14% and 0.7%<sup>[1,2,3]</sup>. It remains a subject of case reports and of small institutional series. Large case numbers reviewed in a single institute was rare and difficult. However, reviews from different series of geographic localizations and populations might be obscure on pathologic features in local area. Further, splenic abscess often occurs in the patients with underlying diseases<sup>[4-8]</sup>. Patients with multiple splenic abscesses (MSA) or immunodeficiency are considered to have a poor prognosis and high mortality<sup>[4,5,9]</sup>. Many surgeons had reported that splenectomy is a better way for treatment of splenic abscess<sup>[3,5,8-10]</sup>. Recently, medical treatment and abscess drainage are proved to be efficient methods in the treatment of splenic abscess<sup>[11-14]</sup>. However, various conditions interfere with the prognosis of splenic abscess, such as underlying diseases, abscess number and size, organism spectra, therapeutic methods and general conditions. There is no single risk factor that can predict

Table 1 Comparison of epidemiology and symptomatology in the reviews

Variable	Chun <i>et al</i> <sup>[17]</sup> 1900-1977	Nelken <i>et al</i> <sup>[5]</sup> 1977-1986	Ooi <i>et al</i> <sup>[18]</sup> 1987-1995	Present study 1986-2004
Number of cases	173	189	287	67
Male:female ratio(%)	104:61 (63)	125:64 (66)	163:80 (67)	41:26 (61)
Mean age (yr)	36.8	Not available	41.1	54.1
Age range (yr)	6 mo-83	6 mo-82	6 mo-92	19-79
Clinical presentations				
Fever (%)	95.4	84	90.8	85
Left upper quadrant pain(%)	42.1	39	49.8	43.3
Splenomegaly(%)	53.9	40	30.7	67.2
Left pleural effusion(%)	19.7	Not available	22.3	41.5

the prognosis exactly till now. APACHE II score is a method to evaluate the general condition and to easily get the score from the patient's general data<sup>[15]</sup>. It has not been adopted in the evaluation of splenic abscess. To further elucidate the prognostic factors in splenic abscess, we have analyzed the various risk factors (including APACHE II score) of splenic abscess in a large series of 67 cases from a single medical center during a period of 19 years.

## MATERIALS AND METHODS

From January 1985 to December 2004, a total of 67 patients with splenic abscess were enrolled. The diagnosis of splenic abscess was made if one of the following criteria was met: (1) microbiologically documented abscess (blood or splenic aspirate) with compatible splenic imaging studies of computed tomography (CT) or ultrasonography (US); (2) Pathologic microscopic examination of the spleen on autopsy, resection or aspirate that revealed abscess formation; (3) Operative findings of splenic abscess on exploratory laparotomy; (4) In the presence of typical clinical manifestations and finding of CT or US, the patients' conditions regressed after antibiotic therapy in cases without interventional therapies (only three cases in this study). Patients with diseases progressing to death and sterile culture were excluded from this study. The demographic, clinical, and laboratory characteristics, underlying diseases, organism spectra, abscess number and size, therapeutic methods, patients' APACHE II scores, and mortality rates were collected and analyzed. The size of abscess is recorded as the largest diameter in either solitary or multiple abscesses. The APACHE II score was evaluated following the criteria of Knaus' report<sup>[15]</sup>. Age, chronic health problem score, Glasgow coma score, and 12 physiologic variables (vital signs, oxygenation, laboratory values; the most severely abnormal of each in the first 24 h of admission) were used to make a sum of scores<sup>[15]</sup>. All the survival cases had been followed clinically for more than 6 mo. Comparison between groups of independent samples was assessed by the Student's *t*-test, one-way ANOVA (*post hoc* multiple comparisons by Scheffe's procedure). The associations between categorical variables were assessed using the  $\chi^2$  or Fisher's exact test. A two-tailed  $P < 0.05$  was considered statistically significant.

## RESULTS

There were 41 males and 26 females with the mean age of  $54.1 \pm 14.1$  years (range 19-79 years). The mean age of males was  $51.9 \pm 13.6$  years, and that of the females was  $57.4 \pm 14.5$  years ( $P = 0.123$ ). Sizes of abscess ranged from 1.5 to 16 cm, with a mean of  $4.02 \pm 2.56$  cm.

The symptoms were fever in 57 patients (85.1%), left upper quadrant pain in 29 patients (43.3%), diffuse abdominal pain in 10 patients (14.9%), left chest wall pain in 3 patients (9%), and dyspnea in 5 patients (7.5%). Twenty five patients (37.3%) suffered from more than two symptoms at the time of diagnosis. The physical examination revealed splenomegaly in 34 patients (50.7%), left upper quadrant tenderness in 30 patients (44.7%), generalized abdominal tenderness in 9 patients (13.4%), left chest basilar rales in 6 patients (8.9%), and left chest basilar dullness in 5 patients (7.5%), leukocytosis over  $10\,000/\text{mm}^3$  in 47 patients (70.1%), and leucopenia in 3 patients (4.5%) (Table 1).

Among the 67 patients, 54 of them (80.6%) had predisposing underlying diseases. Diabetes mellitus (DM) was the leading disease (25 patients, 46.3%). Seven of 54 patients (12.9%) had more than two underlying diseases simultaneously (Table 2). Statistical analysis revealed that the presence of underlying disease did not correlate with any clinicopathologic parameter, including size of abscess, numbers of abscess, age, gender, species of microorganism, and mortality rates of patients.

Of the images of splenic abscess, 65 patients underwent chest roentgenogram study. Forty of sixty-five patients (61.5%) had abnormalities as left lower lung infiltration (13 cases, 20%) or left pleural effusion (27 cases, 41.5%). Further, 66 of 67 patients underwent abdominal US and/or abdominal CT studies, in which 46 patients received both US and CT, 9 patients received US alone, and 11 patients received CT alone. One who had a solitary splenic abscess (SSA) had no image study because of emergent operation for peritonitis. The sensitivity of US and CT was 98.18% and 98.24%, respectively. Splenomegaly was found by images in 45 patients (67.2%). There were MSA in 19 cases (28.4%) and SSA in 48 cases (71.6%) (Table 3). Gas formation in the abscess was found in only 8 patients (11.9%), mainly in patients with gram negative bacillus (GNB) infections (7 cases). In addition

**Table 2 Underlying and predisposing diseases in 67 cases of splenic abscess**

Underlying diseases (n = 67)	Solitary (SSA) (n = 48)	Multiple (MSA) (n = 19)	Extrasplenic abscess (n = 26)
DM (20)	17	3	10 <sup>1</sup>
Endocarditis (7)	7	0	4 <sup>2</sup>
Pancreatitis (5)	2	3	2 <sup>3</sup>
Pancreatitis+DM (2)	1	1	0
Pancreatic cancer (1)	1	0	0
Liver cirrhosis (2)	1	1	1 <sup>4</sup>
Trauma (2)	1	1	0
MDS (2)	0	2	2 <sup>5</sup>
SLE (2)	2	0	0
CHF (1)	1	0	0
Perforated peptic ulcer (1)	1	0	0
Colon perforation+ DM (1)	1	0	1 <sup>6</sup>
Endocarditis+DM (1)	1	0	0
Biliary tract stone	1	0	0
AIDS (1)	0	1	1 <sup>7</sup>
ALL (1)	0	1	0
Aplastic anemia (1)	1	0	0
ESRD+ovarian cancer (1)	0	1	0
COPD+CHF (1)	1	0	0
Lung cancer+DM (1)	1	0	0
Unknown (13)	8	5	5 <sup>8</sup>

DM, diabetes mellitus; MDS, myelodysplastic syndrome; SLE, systemic lupus erythematosus; CHF, congestive heart failure; AIDS, acquired immunodeficiency syndrome; ALL, acute lymphocytic leukemia; ESRD, end stage renal disease; COPD, chronic obstructive pulmonary disease. <sup>1</sup>Liver: 3; subphrenic area: 2; pancreas: 1; anus: 1; gluteal muscle: 1; retroperitoneal cavity: 1; brain+lung: 1. <sup>2</sup>brain: 2; aortic valve: 1; lung: 1. <sup>3</sup>pancreas: 2. <sup>4</sup>gluteal muscle: 1. <sup>5</sup>liver: 2. <sup>6</sup>subphrenic area: 1. <sup>7</sup>liver: 1. <sup>8</sup>liver: 2; brain+lung: 1; retroperitoneal cavity: 1; subphrenic area: 1.

to spleen, 26 of 67 patients (35.8%) had extrasplenic abscesses, with leading site of liver (Table 4). Among them two patients showed two sites of extrasplenic abscesses in the lung and brain. By statistics, we found that MSA tended to develop in non-diabetic patients ( $P=0.053$ ), and in abscess with GNB infection ( $P=0.036$ , Tables 2 and 3). Furthermore, MSA patients experienced a higher mortality rate than SSA patients ( $P=0.011$ , Table 5). Seven of nineteen (36.8%) MSA patients, in contrast to 5 of 48 (10.4%) SSA patients expired eventually. *Klebsiella pneumoniae* (*K. pneumoniae*) (70%) and staphylococcus aureus (60%) were most common pathogens to develop extrasplenic abscess (Table 3). However, statistical analysis revealed no significant correlation between the presence of extrasplenic abscess and any clinicopathologic factor.

Bacteriologic studies revealed that positive microbiological cultures were found in 58 patients (86.6%), and sterile in the other 9 patients (Table 3). Blood culture was positive in 46 of 64 patients (71.8%), and abscess culture in 43 of 46 patients (93.5%). Twenty-eight of thirty patients who had both positive blood and abscess cultures revealed identical pathogens. The microorganisms of 58 cases of positive culture were predominantly GNB (32 cases, 55.2%), with *K. pneumoniae* as the leading pathogen

**Table 3 Microorganisms of blood culture and abscess culture of splenic abscess**

Microorganism (n = 67)	Solitary (n = 48)	Multiple (n = 19)	Extrasplenic abscess (n = 26)
Aerobes			
Gram positive-18			
<i>Streptococcus viridans</i> (SV) (8)	7	1	2 <sup>1</sup>
<i>Staphylococcus aureus</i> (5)	5	0	3 <sup>2</sup>
<i>Enterococcus species</i> (5)	5	0	1 <sup>3</sup>
Gram negative-32			
<i>Escherichia coli</i> (11)	8	3	4 <sup>4</sup>
<i>Klebsiella pneumoniae</i> (KP)(10)	4	6	7 <sup>5</sup>
<i>Pseudomonas species</i> (PS) (5)	4	1	1 <sup>6</sup>
<i>Salmonella species</i> (5)	4	1	2 <sup>7</sup>
<i>Proteus</i> (1)	1	0	0
Gram positive+gram negative-4			
SV+KP (2)	2	0	1 <sup>8</sup>
SV+PS (1)	0	1	1 <sup>9</sup>
SV+PS+KP (1)	0	1	0
Anaerobes-2			
Gram positive			
<i>Propionibacterium acnes</i> (1)	1	0	0
Gram negative			
<i>Bacteroides fragilis</i> (1)	1	0	1 <sup>10</sup>
Mycobacterium-1			
Tuberculosis (1)	0	1	1 <sup>11</sup>
Fungus-1			
<i>Cryptococcus neoformans</i> (1)	0	1	1 <sup>12</sup>
Sterile culture-9	6	3	1 <sup>13</sup>

<sup>1</sup>Brain: 1; liver: 1. <sup>2</sup>lung: 1; retroperitoneum: 1; brain: 1. <sup>3</sup>retroperitoneum: 1. <sup>4</sup>liver: 1; subphrenic area: 1; gluteal muscle: 1; pancreas: 1. <sup>5</sup>liver: 4; brain+lung: 2; subphrenic area: 1. <sup>6</sup>anus: 1. <sup>7</sup>aortic valve: 1; subphrenic area: 1. <sup>8</sup>subphrenic area: 1. <sup>9</sup>gluteal muscle (1). <sup>10</sup>pancreas: 1. <sup>11</sup>liver: 1. <sup>12</sup>liver: 1. <sup>13</sup>pancreas: 1.

(22.4%, Table 3). Statistical analysis revealed that abscesses with GNB were likely to develop multiple focus compared with abscesses with gram positive coccus (GPC) ( $P=0.036$ ). There were 11 MSA in 32 patients (34.4%) with GNB. In contrast, only one of the 18 patients (5.6%) with GPC had MSA. Furthermore, patients with GNB infection also experienced a higher mortality rate than patients with GPC ( $P=0.009$ ). Ten of 32 GNB (31.2%) patients, in contrast to none of 18 (0%) GPC patients expired eventually (Table 5).

In the treatment of splenic abscess, all patients received antibiotic therapy. Splenectomy was performed in 26 patients (38.8%), percutaneous drainage or aspiration in 21 (31.3%), and antibiotic therapy alone in 20 patients (29.9%). Eventually, 12 patients expired (17.9%) at the end of follow-up. Three patients with percutaneous drainage or aspiration initially were finally referred for splenectomy, and all of them survived. Two mortality patients who underwent splenectomy died of predisposing factors as extensive pancreatitis and severe abdominal trauma rather than splenic abscess itself. The mortality rate was 7.7% in patients treated with splenectomy, 28.6% in patients with percutaneous drainage or aspiration, and 20% in patients with antibiotic therapy alone. There was no difference of

Table 4 Locations of extrasplenic abscesses

Location	Case number (%)
Liver	9 (34.6)
Subphrenic area	4 (15.4)
Pancreas	3 (11.5)
Brain	3 (11.5) <sup>1</sup>
Lung	3 (11.5) <sup>1</sup>
Retroperitoneal cavity	2 (7.7)
Gluteal muscle	2 (7.7)
Aortic valve	1 (3.85)
Anus	1 (3.85)

<sup>1</sup>Twenty-six patients had single, and two patients had two sites of extrasplenic abscesses (lung+brain).

mortality rate between the groups (Table 5). But marginally better outcome was found in patients with splenectomy than patients with percutaneous drainage or aspiration ( $P=0.06$ ).

For analysis of patients' outcome, we first applied the APACHE II score for further correlation study. The twelve expired patients had high APACHE II scores over 15 except one. The mean score of 12 expired patients ( $16.1 \pm 3.2$ ) was significantly higher than that of the 55 survivals ( $7.3 \pm 3.8$ ) ( $P<0.001$ ). It was also found that higher scores presented in fatal cases of each category, regardless of underlying disease, abscess number and size, organism spectrum, and different therapeutic methods (data not shown). To summarize our results, we found that patients with multiple splenic abscesses, GNB infection had a higher mortality rate than patients with solitary splenic abscess and GPC infection. Mortality patients also had a higher mean APACHE II score than survival patients (Table 5).

## DISCUSSION

Reports on splenic abscess between 1900 and 1977<sup>[16]</sup>, between 1977 and 1986<sup>[4]</sup>, and between 1987 and 1995<sup>[17]</sup> showed a great variety of causative pathogens with a wide range of demographic and clinical conditions. Reviews of large series of patients with splenic abscess are capable of shedding light on the pathogenesis and clinical characteristics of splenic abscess<sup>[4,16,17]</sup>. Reviews from different geographic localizations and populations might obscure some specific pathologic features in the local area. Therefore, our large series review in single medical center might provide a further insight of the pathogenesis of splenic abscess in Taiwan.

Our patients experienced an older age, and higher percentage of splenomegaly and more left lung change (infiltration or pleural effusion) than that reported by other studies<sup>[4,16,17]</sup> (Table 1). These might be attributed to extensive studies by images. US and CT may help to detect small amount of pleural effusion which is subtle in CXR. Further, US and CT are also more sensitive to demonstrate splenomegaly than physical examination did. With a reported sensitivity of 96%, CT was considered to be superior to US (sensitivity 75-90%) for detecting splenic

Table 5 Prognostic factors of splenic abscess

Variables	Category (n)	Outcome		P
		Cure (n = 55, %)	Mortality (n = 12, %)	
Gender	Female (26)	21 (81)	5 (19)	NS <sup>1</sup>
	Male (41)	34 (83)	7 (17)	
Abscess number*	Solitary (48)	43 (89)	5 (11)	0.011 <sup>1</sup>
	Multiple (19)	12 (63)	7 (37)	
Extrasplenic abscesses	Without (43)	36 (84)	7 (16)	NS <sup>1</sup>
	With (24)	19 (79)	5 (21)	
Underlying diseases	Without (15)	12 (80)	3 (20)	NS <sup>1</sup>
	With (52)	43 (83)	9 (17)	
Diabetes	Without (41)	33 (80)	8 (20)	NS <sup>1</sup>
	With (26)	22 (85)	4 (15)	
Microorganism <sup>a</sup>	GNB (32)	22 (69)	10 (31)	0.0091 <sup>a</sup>
	GPC (18)	18 (100)	0 (0)	
	GNB+GPC (4)	4 (100)	0 (0)	
	Others (4)	2 (50)	2 (50)	
	Sterile (9)	9 (100)	0 (0)	
Treatment	Splenectomy (26)	24 (92)	2 (8)	NS <sup>1</sup>
	PD or FNA+AT (21)	15 (71)	6 (29)	
	AT alone (20)	16 (80)	4 (20)	
Age		53.3±13.4	57.3±17.1	NS <sup>2</sup>
Size of abscess <sup>2</sup>		5.1±3.0	4.0±2.6	NS <sup>2</sup>
Leukocytes/mm <sup>3</sup>		13.1±4.5	9.6±5.9	NS <sup>2</sup>
APACHE II score*		7.3±3.8	16.1±3.2	<0.001 <sup>2</sup>

GNB, gram negative bacillus; GPC, gram positive cocci; PD, percutaneous drainage; FNA, fine needle aspiration; AT, antimicrobial therapy. Categorical data were compared by: 1:  $\chi^2$  test or *F*-test, 2: *t*-test. <sup>a</sup> $P<0.05$  GNB vs GPC. NS: not significant.

abscess<sup>[12,17]</sup>. However, we found that the sensitivity of both CT and US in this study was equal and extremely high (98%). Therefore, US is an easy diagnostic and therapeutic tool for splenic abscess<sup>[18]</sup>.

The cause of splenic infection has been most often a metastatic infection or contiguous distant infection<sup>[4,16,17]</sup>. Recently, changing lifestyles resulted in an increasing prevalence of DM, malignancies, and immunosuppression becomes advanced therapeutic methods. These conditions constitute the increasing predisposing risk for the development of splenic abscess. Underlying diseases such as DM, endocarditis, and other diseases were reported not to be a good predictor for prognosis before. However, immunodeficiency is considered to be a poor prognostic factor and caused a high mortality<sup>[7-8]</sup>. In our series, the most common predisposing factors were still metastatic or contiguous infections. But 10 patients had immunodeficiency disorders (acquired immunodeficiency disease, myelodysplastic syndrome, systemic lupus erythematosus, acute lymphocytic leukemia, malignancies after chemotherapy, and aplastic anemia), and six of ten patients suffered from MSA and expired. Based on the limited case numbers, we cannot arrive at any conclusion about the prognostic role of immunodeficiency disorder.

But actually, we have found many mortality patients with severe illness (due to immunodeficiency) during the initial patients search for this study. They were excluded from this study mostly because of progression of disease to death with uncertain microbiological information. In these patients, multiple microabscesses were hard to be differentiated from micrometastatic or infarction lesions. Therefore, the real incidence of splenic abscess and the percentages of immunodeficient risk might be underestimated.

In contrast to previous reports (*Streptococcus* and *Staphylococcus* species predominant)<sup>[3,4,7,8,10]</sup>, our series revealed GNB were the leading pathogens causing splenic abscess (55.2%). Among GNB, *K. pneumoniae* was the most frequently encountered pathogen (22.4%). It has been reported to be the most common pathogen of liver abscess in Taiwan<sup>[19]</sup>. Further, metastatic splenic infections from liver abscesses caused by *K. pneumoniae* were rare<sup>[19]</sup>. Primary splenic abscess due to *K. pneumoniae* has also been rarely addressed before. In the present study, we have found that extrasplenic abscesses existed in 26 of 67 patients (38.8%), with leading site of liver in 9 (34.6%). Among the 9 liver abscesses, *K. pneumoniae* accounted for 44% of pathogens. We wonder whether it was a sequela of metastatic infection from liver to spleen or a co-infection of both. Nevertheless, these results indicated the significant role of GNB infection in splenic abscess. By statistics, we found that patients with GNB infection were prone to develop multiple splenic abscess ( $P=0.036$ ) and had a higher mortality rate ( $P=0.009$ ) than patients with GPC did. It is a novel finding which was never reported.

In this series, the treatment was carried out by antibiotic therapy alone, percutaneous splenic aspiration and/or drainage, or surgical methods. The mortality rate in patients receiving antibiotic therapy alone or percutaneous splenic drainage was marginally higher than that undergoing splenectomy. This result came from (1) the patient number in each different treatment group was still small, and (2) surgical treatment was not performed in some patients, if patient's condition was too ill to tolerate an operation. Based on these, the prognosis of our patients cannot be predicted by treatment methods exactly. In fact, even the previous inferences were mostly derived from comparison of patients in different series because of the rarity of disease<sup>[5,16,17]</sup>. There is a lack of a prospective cohort study to demonstrate which therapy is superior to others. To overcome this, we first adopted APACHE II score to predict the patients' outcome. The fatal patients had higher APACHE II score ( $16.1 \pm 3.2$ ) than the survivals ( $7.3 \pm 3.8$ ) ( $P < 0.001$ ). It was also found that higher scores presented in fatal cases of each category, regardless of underlying disease, abscess number and size, organism spectrum, and different therapeutic methods. Among the nine expired patients, eight had a score of over 15. Therefore, we thought that a score over 15 was a risk point for splenic abscess, the sensitivity, specificity, positive

predict value, and negative predict value would be 89%, 94%, 80%, and 97%, respectively.

In conclusion, we have obtained a novel finding of GNB serving as a leading pathogen in splenic abscess and provided evidence that multiple splenic abscesses, GNB infection, and high APACHE II scores are poor prognostic factors. Aggressive and early surgical intervention of splenic abscess should be encouraged when these risk factors are present.

## REFERENCES

- 1 Lawhorne TW, Zuidema GD. Splenic abscess. *Surgery* 1976; **79**: 686-689
- 2 Gadacz TR. Splenic abscess. *World J Surg* 1985; **9**: 410-415
- 3 Alonso Cohen MA, Galera MJ, Ruiz M, Puig la Calle J, Ruis X, Artigas V, Puig la Calle J. Splenic abscess. *World J Surg* 1990; **14**: 513-56; discussion 513-56
- 4 Nelken N, Ignatius J, Skinner M, Christensen N. Changing clinical spectrum of splenic abscess. A multicenter study and review of the literature. *Am J Surg* 1987; **154**: 27-34
- 5 Pomerantz RA, Eckhauser FE, Thornton JW, Strodel WE, Knol JA, Zuidema GD. Covert splenic abscess: a continuing challenge. *Am Surg* 1986; **52**: 386-390
- 6 Faught WE, Gilbertson JJ, Nelson EW. Splenic abscess: presentation, treatment options, and results. *Am J Surg* 1989; **158**: 612-614
- 7 Green BT. Splenic abscess: report of six cases and review of the literature. *Am Surg* 2001; **67**: 80-85
- 8 Phillips GS, Radosevich MD, Lipsett PA. Splenic abscess: another look at an old disease. *Arch Surg* 1997; **132**: 1331-135; discussion 1331-135
- 9 Simson JN. Solitary abscess of the spleen. *Br J Surg* 1980; **67**: 106-110
- 10 Smyrniotis V, Kehagias D, Voros D, Fotopoulos A, Lambrou A, Kostopanagiotou G, Kostopanagiotou E, Papadimitriou J. Splenic abscess. An old disease with new interest. *Dig Surg* 2000; **17**: 354-357
- 11 Goerg C, Schwerk WB, Goerg K. Splenic lesions: sonographic patterns, follow-up, differential diagnosis. *Eur J Radiol* 1991; **13**: 59-66
- 12 Tikkakoski T, Siniluoto T, Päivänsalo M, Taavitsainen M, Leppänen M, Dean K, Koivisto M, Suramo I. Splenic abscess. Imaging and intervention. *Acta Radiol* 1992; **33**: 561-565
- 13 Jang TN, Fung CP. Treatment of pyogenic splenic abscess: nonsurgical procedures. *J Formos Med Assoc* 1995; **94**: 309-312
- 14 Chou YH, Tiu CM, Chiou HJ, Hsu CC, Chiang JH, Yu C. Ultrasound-guided interventional procedures in splenic abscesses. *Eur J Radiol* 1998; **28**: 167-170
- 15 Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. *Crit Care Med* 1985; **13**: 818-829
- 16 Chun CH, Raff MJ, Contreras L, Varghese R, Waterman N, Daffner R, Melo JC. Splenic abscess. *Medicine (Baltimore)* 1980; **59**: 50-65
- 17 Ooi LL, Leong SS. Splenic abscesses from 1987 to 1995. *Am J Surg* 1997; **174**: 87-93
- 18 Changchien CS, Tsai TL, Hu TH, Chiou SS, Kuo CH. Sonographic patterns of splenic abscess: an analysis of 34 proven cases. *Abdom Imaging* 2002; **27**: 739-745
- 19 Ko WC, Paterson DL, Sagnimeni AJ, Hansen DS, Von Gottberg A, Mohapatra S, Casellas JM, Goossens H, Mulazimoglu L, Trenholme G, Klugman KP, McCormack JG, Yu VL. Community-acquired *Klebsiella pneumoniae* bacteremia: global differences in clinical patterns. *Emerg Infect Dis* 2002; **8**: 160-166

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