

# Pyogenic Hepatic Abscess

## Changing Trends Over 42 Years

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### Objective

The authors document changes in the etiology, diagnosis, bacteriology, treatment, and outcome of patients with pyogenic hepatic abscesses over the past 4 decades.

### Summary Background Data

Pyogenic hepatic abscess is a highly lethal problem. Over the past 2 decades, new roentgenographic methods, such as ultrasound, computed tomographic scanning, direct cholangiography, guided aspiration, and percutaneous drainage, have altered both the diagnosis and treatment of these patients. A more aggressive approach to the management of hepatobiliary and pancreatic neoplasms also has resulted in an increased incidence of this problem.

### Methods

The records of 233 patients with pyogenic liver abscesses managed over a 42-year period were reviewed. Patients treated from 1952 to 1972 ( $n = 80$ ) were compared with those seen from 1973 to 1993 ( $n = 153$ ).

### Results

From 1973 to 1993, the incidence increased from 13 to 20 per 100,000 hospital admissions ( $p < 0.01$ ). Patients managed from 1973 to 1993 were more likely ( $p < 0.01$ ) to have an underlying malignancy (52% vs. 28%) with most of these (81%) being a hepatobiliary or pancreatic cancer. The 1973 to 1993 patients were more likely ( $p < 0.05$ ) to be infected with streptococcal (53% vs. 30%) or *Pseudomonas* (30% vs. 9%) species or to have mixed bacterial and fungal (26% vs. 1%) infections. The recent patients also were more likely ( $p < 0.05$ ) to be managed by percutaneous abscess drainage (45% vs. 0%). Despite having more underlying problems, overall mortality decreased significantly ( $p < 0.01$ ) from 65% (in 1952 to 1972 period) to 31% (in 1973 to 1993 period). This reduction was greatest for patients with multiple abscesses (88% vs. 44%;  $p < 0.05$ ) with either a malignant or a benign biliary etiology (90% vs. 38%;  $p < 0.05$ ). Mortality was increased ( $p < 0.02$ ) in patients with mixed bacterial and fungal abscesses (50%). From 1973 to 1993, mortality was lower ( $p = 0.19$ ) with open surgical as opposed to percutaneous abscess drainage (14% vs. 26%).

### Conclusions

Significant changes have occurred in the etiology, diagnosis, bacteriology, treatment, and outcome of patients with pyogenic hepatic abscesses over the past 4 decades. However,

mortality remains high, and proper management continues to be a challenge. Appropriate systemic antibiotics and fungal agents as well as adequate surgical, percutaneous, or biliary drainage are required for the best results.

Pyogenic hepatic abscess is a rare but highly lethal problem. During the first 3 decades of this century, py-lephlebitis secondary to appendicitis was the most common cause, and overall mortality approached 75% to 80%.<sup>1-3</sup> During the 1950s, 60s, and early 70s, the most common etiology had become a mixture of benign and malignant biliary tract obstruction.<sup>2-4</sup> However, most of these patients had multiple abscesses, and overall mortality remained as high as 45% to 50%. Over the past 2 decades, the introduction of ultrasound and computed tomography (CT), percutaneous and endoscopic cholangiography, and biliary drainage as well as guided aspiration and percutaneous drainage of abscesses, has dramatically altered both the diagnosis and treatment of these patients. Moreover, a more aggressive operative and nonoperative approach to the management of hepatobiliary and pancreatic neoplasms has resulted in an increased incidence of pyogenic hepatic abscesses. To document these changes, we reviewed our experience with pyogenic liver abscesses over a 42-year period and compared patients managed from 1952 to 1972 with those seen from 1973 to 1993.

## METHODS

### Patient Population

The medical records of all patients with a diagnosis of hepatic abscess seen at The Johns Hopkins Hospital over a 42-year period from January 1952 through December 1993 were compared with those of the patients managed from January 1952 through December 1972 who were the subject of a prior report.<sup>4</sup> Only patients with pyogenic hepatic abscesses confirmed by needle aspiration, surgical exploration, or autopsy were included in the study. Solitary, multiple macroscopic, and microscopic abscesses were included; however, 30 patients with generalized sepsis and microscopic abscesses in several organs including the liver were excluded. Eight patients with documented amebic liver abscesses also were excluded. In the 1973 to 1993 period, eight patients with pure fungal abscesses and one patient with a hepatic abscess caused by a mycobacterial infection in the absence

of other bacteria also were excluded. Further details about the patient population are listed in Table 1. Eighty patients were seen from 1952 to 1972 compared with 153 from 1973 to 1993. When controlled by the number of hospital admissions during these two periods, this increased incidence was statistically significant ( $p < 0.05$ ). The more recent patients were slightly younger and there was a greater proportion of men than women, but these differences were not statistically significant.

The etiology of the abscesses were divided into six categories based on the route of extension of infection: 1) through the bile ducts, 2) by way of the portal vein, 3) by direct extension, 4) from blunt or penetrating trauma, 5) through the hepatic artery, or 6) of obscure origin, cryptogenic, when no primary source of infection is found, even after abdominal exploration or autopsy. The etiology of the liver abscesses during the two 21-year periods is shown in Figure 1. In both periods, a biliary etiology was most common (51% vs. 60%). However, malignant biliary obstructions were more likely ( $p < 0.05$ ) to be the cause in the 1973 to 1993 period (Table 1). Adenocarcinoma of the pancreas was the most common cause of malignant obstruction in the earlier period (16% vs. 7%), whereas cholangiocarcinoma became more common in the recent period (2% vs. 25%;  $p < 0.05$ ). The use of in-

**Table 1. PATIENT POPULATION**

	1952-1972	1973-1993
No. of patients	80	153
Incidence, age, gender		
Incidence/10 <sup>5</sup> admissions	13	20*
Mean age (yr)	60.0	55.5
Male (%)	50	57
Associated diseases		
HBP malignancy (%)	23	42*
Benign biliary (%)	28	18
Prior gastric surgery (%)	26	7*
Diabetes mellitus (%)	15	15
Cirrhosis (%)	13	5
Abscesses		
Solitary (%)	40	52
Multiple (%)	60	48
Location of abscesses		
Both (%)	49	22*
Right (%)	38	63*
Left (%)	14	14

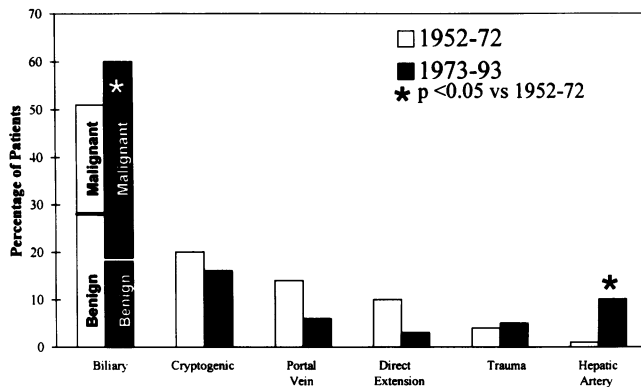
HBP = hepatobiliary or pancreatic.

\*  $p < 0.05$  vs. 1952-1972.

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**Figure 1.** Etiology of pyogenic hepatic abscesses from 1952 to 1993 period.

dwelling biliary stents in these patients also was significantly different ( $p < 0.01$ ) during these two periods (0% vs. 33%). Liver metastases also increased as an underlying cause in recent years (1% vs. 7%). An hepatic artery source also increased in recent years (1% vs. 10%;  $p < 0.05$ ), largely because of an increase in severely immunosuppressed patients (0% vs. 7%) and the use of hepatic artery embolization (0% vs. 6%). No significant differences were noted, however, in the incidence of diabetes mellitus, underlying cirrhosis, chronic alcoholism, pyelonephritis, chronic pancreatitis, or steroid usage (Table 1). In the recent period, four patients had either the acquired immune deficiency syndrome or a human immunodeficiency virus.

Relatively more solitary abscesses were seen in recent years, but this difference was not statistically significant (Table 1). However, the incidence of bilateral abscesses was reduced ( $p < 0.05$ ), and abscesses confined to the right lobe were increased ( $p < 0.05$ ) in the recent period (Table 1). This change is most likely due to the fact that 88% of the biliary abscesses were bilateral in the earlier series, whereas patients with malignant biliary obstruction and indwelling stents often develop a solitary right-sided abscess.

### Clinical Features and Laboratory Data

In both periods, the most common presenting symptom was fever (92% vs. 89%), and about half the patients also had chills (54% vs. 49%). Pain was more common ( $p < 0.02$ ) in the earlier period (74% vs. 55%). Again, this change is probably because patients with indwelling tubes and a small abscess rarely have significant pain. Weight loss also was common (51% vs. 43%), whereas diarrhea was uncommon (23% vs. 10%) in these patients. The most frequent physical findings were a tender liver (65% vs. 55%), jaundice (54% vs. 50%), and hepatomeg-

aly (48% vs. 35%). These signs have not changed significantly over the 4 decades.

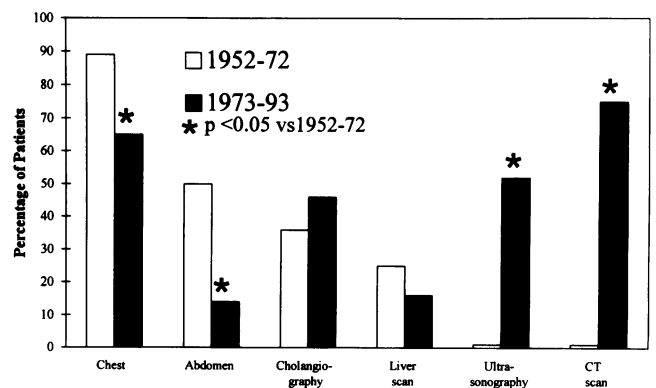
In recent years, the percentage of patients with abnormal liver function test results has decreased ( $p < 0.05$ ). This trend was true for total bilirubin (68% vs. 49%), alkaline phosphatase (90% vs. 70%), aspartate aminotransferase (90% vs. 64%), and alanine aminotransferase (82% vs. 67%). This difference is also probably because of the increased incidence of abscesses in patients with indwelling biliary stents. Conversely, no dramatic changes were observed in the percentage of patients with anemia (69% vs. 77%), leukocytosis (88% vs. 75%), prolonged prothrombin time (52% vs. 62%), or hypoalbuminemia (62% vs. 71%).

### Roentgenographic Evaluation

The roentgenographic tests used to evaluate these patients are shown in Figure 2. In the earlier period, chest x-rays were used routinely, and half the patients also had plain abdominal films. The use of both of these basic x-rays has decreased significantly ( $p < 0.05$ ) in recent years. Cholangiography remains an important diagnostic test in 30% to 40% of patients. Liver scans were used in approximately 20% of patients before 1973, but liver scan use has declined in recent years. Conversely, almost all patients now undergo either ultrasound or CT, which were not available before 1973. Only five of the recent patients have had a magnetic resonance scan.

### Microbiologic Data

Information regarding liver, blood, and bile cultures is listed in Table 2. Cultures were taken directly from the abscess in the majority of patients. Similarly, blood cultures were available in most patients in both periods. Significantly more patients ( $p < 0.05$ ) had bile cultures in



**Figure 2.** Roentgenographic evaluation of pyogenic hepatic abscesses from 1952 to 1993 period.

**Table 2. MICROBIOLOGIC DATA**

	1952-1972 (%)	1973-1993 (%)
<b>Liver</b>		
Culture taken	71	88
Culture positive	95	97
Anaerobes	25	25
Resistant	NA	25
Fungal	1	22*
<b>Blood</b>		
Culture taken	75	82
Culture positive	60	56
Anaerobes	10	32*
Resistant	NA	10
Fungal	0	11*
<b>Bile</b>		
Culture taken	19	50*
Culture positive	93	84
Anaerobes	7	15
Resistant	NA	37
Fungal	0	37*

NA = not available; Resistant = bacteria resistant to most antibiotics.

\*  $p < 0.05$  vs. 1952-1972.

recent years, which is a reflection of the increased use of indwelling biliary stents. The majority of abscess and bile cultures were positive, whereas 55% to 60% of blood cultures grew bacteria. The incidence of anaerobes in the abscess was unchanged, whereas the increased incidence ( $p < 0.05$ ) of positive anaerobic blood cultures may reflect better culture techniques. Information on the incidence of multiple-resistant bacteria was not available in the earlier period but generally was not a major problem in the 1950s and 1960s. However, 25% of the abscesses and 37% of the bile cultures now harbor these resistant organisms. Similarly, the association of fungi with pyogenic liver abscesses was very uncommon before 1973. However, fungi, usually *Candida* species, were isolated from 22% of the abscess, 37% of the bile, and 11% of the blood cultures ( $p < 0.05$ ). This trend also reflects the frequent and prolonged use of broad-spectrum antibiotics in patients with indwelling biliary stents.

## Treatment

More than 90% of patients received some form of treatment in both periods (Fig. 3). Before 1973, approximately one third of patients received antibiotics alone without any form of abscess or biliary drainage. Most of these patients receiving only antibiotics or no therapy had end-stage malignancies or died before the establishment of a definitive diagnosis. This treatment category has essentially disappeared ( $p < 0.05$ ) in recent years. The use of antifungal agents in patients with combined

bacterial and fungal abscesses will be the subject of a separate report.<sup>5</sup> In both periods, approximately 35% of patients underwent open surgical drainage. The use of biliary drainage without abscess drainage has diminished slightly from approximately 15% to 10%. However, in the earlier period, these procedures were open biliary operations, whereas currently percutaneous biliary stent placements or exchanges are usually performed. The most dramatic change in treatment is the use of percutaneous abscess drainage, which was not available before 1973 and is now used in approximately 45% of patients ( $p < 0.05$ ). Percutaneous aspiration without drainage also has been used in a small percentage of carefully selected patients since 1973. Nine of 86 patients (10%) initially managed by percutaneous abscess drainage subsequently required open surgical drainage.

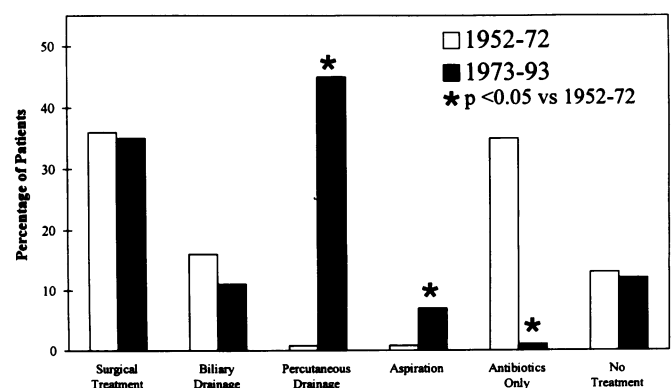
## Morbidity, Mortality, and Statistics

Morbidity and mortality were analyzed with respect to the initial form of therapy. Mortality also was evaluated on the basis of the underlying etiology, the number of abscesses and the bacteriology. For each period, multiple clinical, laboratory, and microbiologic parameters were correlated with outcome. These risk factors were compared for the two periods. Data from the 1952 to 1972 and 1973 to 1993 periods were compared by Student's *t* test, the Fisher's exact test, and the chi square test as appropriate. Statistical significance was considered to have been achieved when the *p* value was less than 0.05.

## RESULTS

### Roentgenographic Findings

The percentage of roentgenographic studies that showed the liver abscess is listed in Table 3. The CT scan was the most accurate (93%). The ability of CT scanning



**Figure 3.** Treatment methods of pyogenic hepatic abscesses from 1952 to 1993 period.

**Table 3. ROENTGENOGRAPHIC ABNORMALITIES**

	1952-1972 (%)	1973-1993 (%)
CT scan	NA	93
Ultrasound	NA	83
Liver scan	70	72
Cholangiogram	66	64
Abdominal x-ray	40	50

CT = computerized tomography; NA = not available.

to detect abscesses as small as 0.5 to 1.0 cm made this study slightly more accurate than was ultrasound (83%). In comparison, radionuclide scans of the liver were less accurate (70% to 72%), and this fact did not change over the 4 decades. Liver abscesses of biliary origin communicated with the biliary tree and were shown by cholangiography in approximately two thirds of the patients. Abdominal x-rays showed gas in the abscess or other less specific abnormalities in only 40% to 50% of the patients.

### Microbiologic Results

The results of the liver abscess cultures are shown in Figure 4. In both periods, *E. coli*, *Klebsiella*, and streptococcal species were the organisms most commonly isolated. In comparing the two periods, however, the incidence of *E. coli* infections has decreased ( $p < 0.05$ ), and the incidence of *Klebsiella*, streptococcal ( $p < 0.05$ ), staphylococcal ( $p < 0.05$ ), and *Pseudomonas* ( $p < 0.05$ ) species has each increased. Again, these changes are likely a reflection of the increased use of indwelling biliary stents in the 1973 to 1993 period. The other dramatic change that has occurred is the appearance of fungi in 26% of the abscess cultures in the 1973 to 1993 period compared with only 1% in the 1952 to 1972 period ( $p < 0.01$ ). This significant change reflects the increased use of broad-spectrum antibiotics in these patients with stents who have frequent episodes of cholangitis. Among the anaerobes, the relative frequency of *Bacteroides*, clostridia, and streptococcal species was relatively equal in both periods. The spectrum of organisms isolated from blood and bile cultures was essentially identical to those isolated from the abscesses in both periods.

### Mortality

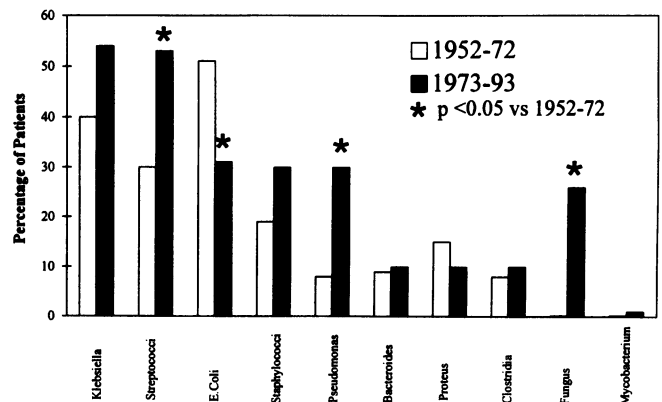
Data on mortality are shown in Figures 5A, 5B, 5C, and 5D. The overall mortality has decreased significantly ( $p < 0.05$ ) from 65% in the 1952 to 1972 period to 31% in the 1973 to 1993 period (Fig. 5A). This change is largely be-

cause of a significant ( $p < 0.05$ ) reduction in the mortality observed in multiple abscesses (88% vs. 45%). However, the mortality also has decreased for solitary abscesses (31% vs. 19%), but this change did not reach statistical significance. When viewed by etiology, mortality has decreased in all categories except the hepatic artery route where the number of patients was quite small. However, these decreases only reached statistical significance ( $p < 0.05$ ) in the malignant and benign biliary etiologic groups (Fig. 5B). Before 1973, mortality was highest in patients with pure aerobic and lowest in patients with pure anaerobic abscesses (Fig. 5C). However, in the 1973 to 1993 group of patients, the type of infection no longer influenced outcome. In comparing the two periods, the reduction in mortality in patients with pure aerobic abscesses was statistically significant ( $p < 0.05$ ).

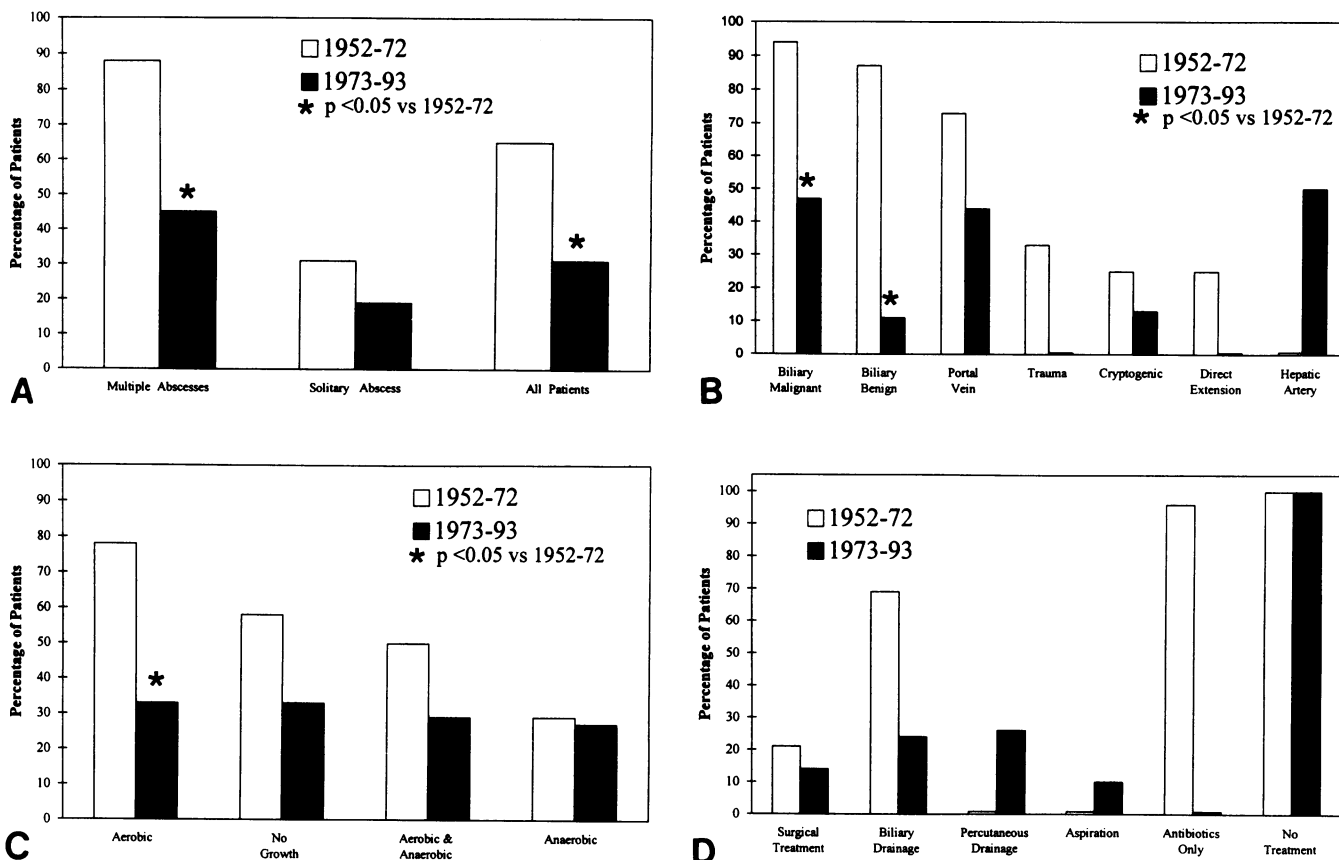
Mortality also was assessed by the type of treatment (Fig. 5D). In the 1952 to 1972 period, mortality was 100% when patients were treated with antibiotics alone or received no treatment. In the 1973 to 1993 period, no patient received antibiotics alone, whereas the uniform mortality without treatment did not change. The mortality with biliary drainage has decreased in the recent period as a shift has taken place from operative to non-operative biliary drainage. However, this reduction did not achieve statistical significance because of the relatively small number of patients. The mortality from surgical drainage, in association with systemic antibiotics, has remained low. In fact, in the 1973 to 1993 period, the mortality from surgical drainage was actually lower than that for percutaneous abscess drainage (14% vs. 26%;  $p = 0.19$ ). Of the 10 patients managed by aspiration alone without drainage, 1 patient (10%) with a solitary abscess died.

### Risk Factors

The factors that were associated with a statistically significant increase in mortality in the 1952 to 1972 and



**Figure 4.** Microbiologic data of pyogenic hepatic abscesses from 1952 to 1993 period.



**Figure 5.** (A) Mortality by number of abscesses. (B) Mortality by etiologic factors. (C) Mortality by microbiologic factors. (D) Mortality by treatment.

1973 to 1993 periods are listed in Table 4. During both periods, multiple abscesses, an associated malignancy, jaundice, hypoalbuminemia, leukocytosis, bacteremia, and a significant complication were associated with in-

creased mortality. During the 1952 to 1972 period, advanced age, a biliary etiology, an elevated AST, and an aerobic infection correlated with increased mortality. However, these risk factors were no longer significant in the 1973 to 1993 period. Conversely, presentation in septic shock was an additional risk factor in the 1973 to 1993 period, but no data on this parameter were available for the 1952 to 1972 period. Finally, a fungal infection also correlated with increased mortality in the 1973 to 1993 period, but this parameter was not significant in the 1952 to 1972 period, partly because only one patient had a fungal abscess.

**Table 4. RISK FACTORS: P VALUES**

	1952-1972	1973-1993
Age >70 yr	<0.05	NS
Biliary etiology	<0.001	NS
Elevated AST	<0.005	NS
Aerobic infection	<0.001	NS
Multiple abscesses	<0.001	<0.002
Associated malignancy	<0.001	<0.001
Jaundice	<0.001	<0.01
Hypoalbuminemia	<0.01	<0.01
Leukocytosis	<0.05	<0.01
Bacteremia	<0.005	<0.01
Significant complication	<0.05	<0.001
Septic shock	NA	<0.001
Fungal infection	NS	<0.02

AST = alanine aminotransferase; NA = not available; NS = not significant.

**DISCUSSION**

To document changes in the cause, diagnosis, bacteriology, treatment, and outcome of patients with pyogenic hepatic abscesses, we compared 80 patients treated from 1952 to 1972 with 153 patients managed at The Johns Hopkins Hospital from 1973 to 1993. In the more recent period, the incidence was increased, largely because of a more aggressive approach to the management of hepatobiliary and pancreatic neoplasms. The use of indwelling

biliary stents also has altered the bacteriology, and the frequent use of broad-spectrum antibiotics in these patients has led to the emergence of mixed bacterial and fungal abscesses. Conversely, better imaging techniques have improved diagnosis, and the development of percutaneous abscess and nonoperative biliary drainage also has contributed to a significant ( $p < 0.01$ ) reduction in mortality from 65% to 31%. However, mortality remains high, and the management of pyogenic liver abscesses remains a diagnostic and therapeutic challenge in the mid 1990s.

Over the 4 decades of this analysis, obstruction of the biliary tract was the most common underlying etiology of pyogenic hepatic abscesses. However, a shift has occurred from relatively more benign to relatively more malignant obstructions as the cause for liver abscesses. In this regard, perihilar cholangiocarcinoma has emerged as the most frequent single underlying cause from 1973 to 1993. During this period, 34 of 153 patients (22%) had a bile duct malignancy. The use of large bore Silastic transhepatic stents in these patients is associated with abscess formation.<sup>6</sup> Conversely, this strategy also may lead to improved survival in both palliated and resected patients.<sup>7,8</sup> Interestingly, this analysis suggests that when liver abscesses do form in these patients, they are less likely to be associated with pain and more likely to have normal liver function test results. In addition, these patients often have relatively resistant *Klebsiella*, *Enterobacter*, and *Pseudomonas* species as well as *Candida* in their bile that may require a different spectrum of antibiotic and antifungal therapy.

In addition to these patients with cholangiocarcinoma, the recent series also includes a number of patients with hepatic metastases who have undergone hepatic artery catheterization as well as some severely immunocompromised patients. Branum et al.<sup>9</sup> from Duke also have reported an increased incidence of patients with underlying malignancy and significant immunosuppression among their patients with pyogenic hepatic abscesses. Wong and associates<sup>10</sup> also have reported liver abscesses after hepatic artery catheterization procedures in patients with cancer. Moreover, both Civardi et al.<sup>11</sup> and Lambiase and colleagues<sup>12</sup> have reported liver abscesses in patients with the acquired immune deficiency syndrome.

The development of ultrasound and CT in the 1970s has revolutionized the diagnosis of many diseases. This study confirms the advantages of CT and ultrasound over radionuclide liver scans, cholangiography, and plain abdominal x-rays in diagnosing hepatic abscesses. This report confirms the impression of Yinnon et al.<sup>13</sup> that ultrasound and CT have facilitated the earlier diagnosis and percutaneous drainage, thereby contributing to improved survival. This series also suggests that CT is

the diagnostic test of choice. Magnetic resonance imaging also has been touted for the diagnosis of pyogenic liver abscesses.<sup>14,15</sup> However, the high cost, length of the study, and lack of easy access for drainage have limited the usefulness of magnetic resonance imaging in managing these patients.

The importance of anaerobic organisms in pyogenic liver abscesses was first appreciated 25 to 30 years ago. This analysis suggests that neither the incidence nor the type of anaerobic bacteria found in hepatic abscesses has changed over the past 2 decades. However, the emergence of abscesses with bacteria resistant to multiple antibiotics as well as mixed bacterial and fungal abscesses is a relatively new phenomenon. The high incidence of resistant bacteria seen in this series is a reflection of the relatively large number of patients with indwelling biliary stents, recurrent cholangitis, and repeated antibiotic treatment. These factors also play a significant role in the high incidence of fungal superinfection. This latter problem has been noted by others,<sup>9,11,16</sup> especially in patients with underlying hematologic malignancies. A more complete discussion of pure and mixed fungal liver abscesses will be the subject of a separate report.<sup>5</sup>

Over the past 2 decades, the introduction and refinement of percutaneous drainage techniques have dramatically altered the management of patients with pyogenic hepatic abscesses. Several groups<sup>9,12,13,17,18</sup> have documented that a significant proportion of patients can be managed with a combination of systemic antibiotics and percutaneous drainage with excellent results. The present report confirms this trend and conclusion. Percutaneous and surgical drainage are not considered competitive but, rather, complimentary techniques. Most solitary and some carefully selected macroscopic multiple abscesses are amenable to percutaneous abscess drainage. Moreover, multiple microscopic abscesses due to biliary tract obstruction may be managed by percutaneous biliary drainage. Surgical drainage is usually reserved for patients who have failed percutaneous drainage, those who require surgical management of the underlying problem, and some patients with multiple macroscopic abscesses and others on steroids or with ascites.

Whether the combination of percutaneous aspiration and systemic antibiotics without drainage is appropriate, therapy remains a controversial issue. Several groups have recently reported reasonable results with this technique.<sup>11,17,19</sup> The largest experience was recently reported by Giorgio et al.<sup>19</sup> from Naples, Italy. This group performed an average of 2.2 needle aspirations in 115 patients with pyogenic hepatic abscesses and report resolution of symptoms and hepatic lesions in 98% of patients. Stain et al.<sup>17</sup> from the University of Southern California used this technique in 29 of 54 patients (54%) and reported success in 23 of the 29 patients (79%) with 2

deaths (7%). Robert et al.<sup>20</sup> from Geneva, Switzerland, attempted aspiration in 16 of 29 patients (55%), but 9 (56%) required drainage and 2 (13%) died. In the present series, percutaneous aspiration was used in only 10 of 153 recent patients (7%), and 1 of these 10 patients (10%) died. Thus, this technique may be applicable to carefully selected patients with the philosophy to have a low threshold to perform drainage if signs of sepsis persist.

Several recent analyses have attempted to define risk factors for a poor outcome in patients with pyogenic hepatic abscesses.<sup>9,21-23</sup> In a univariate analysis of 73 patients, Lee et al.<sup>21</sup> from Taiwan found several of the same parameters to be risk factors as were identified in this study such as multiple abscesses, jaundice, hypoalbuminemia, and leukocytosis. In their multivariate analysis, hypoalbuminemia, leukocytosis, and a pleural effusion were independent predictors of mortality. In a multivariate analysis of 46 patients, Mischingier et al.<sup>22</sup> from Austria found that a high Acute Physiology and Chronic Health Evaluation (APACHE) II score, anemia, and hyperbilirubinemia were the best predictors of a poor outcome. In a much larger series of 384 patients from Taiwan, Chou et al.<sup>23</sup> identified advanced age, altered renal function, hypoalbuminemia, and hyperbilirubinemia to be the best predictors in a multivariate analysis. In the present study, only a univariate analysis was performed. Although jaundice and hypoalbuminemia also were risk factors, the strongest predictors statistically were multiple abscesses, associated malignancy, significant complications, and septic shock. Thus, no general consensus has been achieved regarding risk factors, and discrepancies may be because of different patient populations.

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## Discussion

DR. THOMAS R. GADACZ (Augusta, Georgia): President Thompson, Dr. Copeland, Members, and Guests. Thank you for the opportunity of commenting on Dr. Pitt's paper.

It indeed is a very important paper. As a matter of fact, Dr. DeBakey addressed this issue back in 1938. Liver abscesses are not a new problem and continue to vex us.

Dr. Pitt and his colleagues have very nicely updated the causes, treatment, and outcome of liver abscess, especially some of the changes in etiology. I have two questions and a comment about treatment.

First, what factors contributed to the higher mortality in those patients who had percutaneous drainage? They had a 26% mortality; whereas, those that had inoperative drainage had a 14% mortality.

Were the underlying causes in these two groups of patients significantly different regarding risk factors, or did they represent inadequate percutaneous drainage?

Second, what percent of patients with stents developed an