Review Article

The Evolving Nature of Hepatic Abscess: A Review

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Abstract

Hepatic abscess (HA) remains a serious and often difficult to diagnose problem. HAs can be divided into three main categories based on the underlying conditions: infectious, malignant, and iatrogenic. Infectious abscesses include those secondary to direct extension from local infection, systemic bacteremia, and intra-abdominal infections that seed the portal system. However, over the years, the etiologies and risks factors for HA have continued to evolve. Prompt recognition is important for instituting effective management and obtaining good outcomes.

Introduction

Hepatic abscess (HA) can be defined as an encapsulated collection of suppurative material within the liver parenchyma,[1,2] which may be infected by bacterial, fungal, and/or parasitic micro-organisms.[2] Since the majority of HAs in the Western world are infected with bacteria,[2,3] pyogenic liver abscess will be the focus of this review.

In the early 1900s, the most common cause of HA was pylephlebitis secondary to appendicitis.[4] In the late 1900s, biliary tract disease emerged as the most frequent culprit,[4,5] and it remains the most common cause of HA today.[2,6,7,8] More recently, there has been an increase in the incidence of HA arising in association with malignancies and their treatment, including HA from liver metastasis[4,9] and as complications of transarterial chemoembolization (TACE) or radiofrequency ablation (RFA).[10–14]

Although the frequency of HA varies by region,[15] the overall incidence is fairly low, ranging from 2.3 cases per 100,000 hospital admissions in North America[15] to 275.4 per 100,000 in Taiwan.[16] In the early 1900s, mortality was as high as 75%–80%,[4] while today, mortality is markedly decreased, ranging from 10%–40%.[8] This is due to improvements in antibiotic therapy and interventional procedures for the treatment of HA.[3,4,6]

Although mortality is improved, it is still high, making early diagnosis of HA exceedingly important to the clinical outcome. HA can be difficult to diagnose, and the symptomatology is variable. Often, objective findings are nonspecific,[16,17] and therefore, diagnosis relies largely on imaging.[2]

The aim of this review is to describe some of the changes in important risk factors, mechanisms, and patterns of development of HA and to review the current recommendations for the diagnosis and treatment of this condition.

Risk Factors

There are many risk factors associated with the development of HA and increased mortality from HA. These factors are detailed in Table 1. Risk factors predisposing patients to HA range from diabetes mellitus (DM), cirrhosis, general immune-compromised state, use of proton pump inhibitor (PPI) medications, gender, and age.

DM is a predisposing factor for HA that is well documented in the literature. [5,18,19] Studies have found DM as a concomitant disease in 29.3%–44.3% of patients with HA.[5,19] Diabetic patients are also more likely to present with multiple abscesses.[19] There are several pathophysiologic features of DM that contribute to higher infection risk.[18,20] For instance, hyperglycemia is known to alter neutrophil metabolism.[21] Diabetics also have been shown to have impaired polymorphonuclear leukocyte (PMN) chemotaxis and phagocytosis,[18,20] which weakens their immune defense against infections and leaves them more susceptible to abscess formation.

Like diabetics, patients with liver cirrhosis have an increased risk of HA due to their immune-compromised state.[7] Cirrhotics are 15.4 times more likely to develop HA than the general population.[7,22]

Other conditions and treatments may compromise the immune system and render it inadequate to counteract pathogens. These include various immunodeficiencies, chemotherapy, solid malignancies, immunosuppression therapy after organ transplant,[20] as well as splenectomy,[23] all of which have been associated with an increased risk of HA.

The use of PPI medications has also been found to increase the risk of HA formation.[24] This is presumably because PPI medications increase the gastric pH, which decreases the natural gastric defense against bacteria.[24] In a large case-control study, Wang *et al.* demonstrated a dose-response relationship between HA formation and dose of PPI over a 90 day period.[24] Although this was a large study,

Keywords: Liver abscess; Liver neoplasms; Iatrogenic disease; Risk factors.

Abbreviations: ALP, alkaline phosphatase; ALT, alanine aminotransferase; AST, aspartate aminotransferase; CEUS, contrast-enhanced ultrasound; CT, computed tomography; DM, diabetes mellitus; EBA, enterobiliary anastomosis; FDA, Food and Drug Administration; GGT, gamma glutamyl transpeptidase; HA, hepatic abscess; HCC, hepatocellular carcinoma; INR, international normalized ratio; IV, intravenous; MRI, magnetic resonance imaging; PD, percutaneous drainage; PMN, polymorphonuclear leukocyte; PO, oral, PPI, proton pump inhibitor; RFA, radiofrequency ablation; SD, surgical drainage; TACE, transarterial chemoembolization; US, ultrasound; WBC, white blood cell count.

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Table 1. Risk factors for development of hepatic abscess (HA) and increased mortality from HA

Increased risk of developing HA	Increased mortality from HA
Diabetes mellitus*[5,8,19]	Malignancy[16]
Liver cirrhosis*[22]	Diabetes mellitus*[5,16]
Immune-compromised state[20]	Liver cirrhosis*[22]
Use of PPI[24]	Male gender*[16]
Advanced age[19]	Multiorgan failure[16]
Male gender*[16]	Sepsis[5]
	Infection with mixed organisms[4]
	HA rupture[16]
	Abscess size > 5 cm[5]
	Respiratory distress[16]
	Hypotension[16]
	Jaundice[16]
	Extrahepatic involvement[16]

*Diabetes mellitus, liver cirrhosis and male gender are risk factors for both development and increased mortality of HA.

encompassing 10 years of data, it was conducted exclusively in Taiwan, where the incidence of HA in general is high. Additionally, control subjects were not matched for comorbidities or indication for PPI use. Both of these factors may have had some influence on their findings.

Most cases of HA present at advanced age. One study reported a mean age > 57 years.[19] This finding suggests that older individuals are more susceptible to bacterial infection and thus abscess formation.[21] However, more research is needed to clarify the mechanism of this association.

In a 10-year audit of experience with HA from 1989 to 1999, Lee *et al.* found the ratio of males to females presenting with HA was about 2 to 1.[5] This was confirmed by Pang *et al.*[17] and Lin *et al.*[25]

Morbidity and Mortality

As previously mentioned, mortality remains high, although it has decreased over time. Several associated factors and comorbid conditions have been implicated in the risk of death from HA.[8] A study by Chen *et al.* divided a group of 134 patients with primary HA into a mortality and a survivor group and identified several risk factors for increased mortality, including male gender, malignancy, multi-organ failure, and HA rupture.[16] Other signs and symptoms found to be associated with the mortality group in this study included respiratory distress, hypotension, jaundice, and extrahepatic involvement, such as endopthalmitis.[16] The latter mentioned signs were indicators of higher comorbidity, which not surprisingly were associated with higher mortality in those patients.[16] A similar study by Lee *et al.* found that diabetes, sepsis, and the presence of larger abscesses (> 5 cm) were additional factors associated with higher mortality[5] that were not identified as significant in the study by Chen *et al.*[16] In contrast to that study, Lee *et al.* did not find a significant difference in mortality by gender.[5] Although these studies were conducted in the same region and used very similar sample sizes, the difference in findings could be explained by the inclusion criteria. Chen *et al.* included only primary HA, whereas Lee *et al.* did not specify the diagnosis as primary or secondary.

The theme of immune compromise is also seen in the mortality rates for HA. Mortality rates for HA in patients with associated malignancy was reported to be double that of cancer-free patients.[26] As reported by Lin *et al.*, patients with hepatocellular carcinoma (HCC) and HA had a higher 60-day mortality rate compared to those with HCC only.[15] Additionally, cirrhosis was associated with a 4-fold increase in the risk of death from HA.[22] Mortality was also reported to increase when HA contained mixed organisms or fungal infection.[4]

Categorization

For the purposes of this review, we have divided HA into three subgroups based on category: infectious, malignant, and iatrogenic. There are some areas of overlap between categories, as depicted in Figure 1.

Infectious Abscess

Pathogens may gain access to the liver through contiguous spread from infection of neighboring tissue, from blunt or penetrating trauma to the abdomen,[9,27] and through hematogenous spread (Fig. 2).[2] The latter most commonly occurs due to systemic bacteremia or in intra-abdominal infections. However, bacteremia is only detectable in 43% of HAs,[9] making diagnosis of HA in this instance increasingly difficult. In cases of intra-abdominal infection, including appendicitis and diverticulitis, bacteria can seed the portal vessels, causing pylephlebitis and portal pyemia, ultimately leading to HA formation.[6,7] A recent cohort study of 54,147 patients with diverticular disease and 216,588 matched controls found the incidence of HA to be 2.44-fold higher in those with diverticular disease compared to controls.[28] This study included patients with both diverticulosis and diverticulitis.[28] Of them, 10%–25% had diverticulitis or related complications during the 4–8 year follow-up period.[28] Since diverticulitis seems more likely to cause mucosal defect or perforation than diverticulosis, the inclusion of diverticulosis patients is interesting and suggests that the incidence of HA in this group may have been even higher if the study had examined only diverticulitis patients. With the development of diagnostic methods to facilitate early detection and surgery to resolve the infection before spread can occur, appendicitis and diverticulitis have become much less frequent causes of HA.

Nonmetastatic colorectal cancer has also been associated with HA formation. This link is thought to be due to local destruction of the mucosa by the tumor, which allows invasion of bacteria and entry into the bloodstream.[18,29–31] Similar cases have also been reported postpolypectomy, where polyp removal caused a microperforation in the colon.[32] Under these circumstances, bacteria gain access to the portal venous system and then to the liver bed.[8,20] In some of these cases, the HA was the presenting sign[30] and has been considered to be a herald of silent colon cancer.[5]

Currently, the most common route of infection is the biliary tree, responsible for 30%–50% of cases of HA.[7,33] Biliary infections occur mainly in the setting of obstruction from gallstone disease, malignancy, or stricture,[4,6] leading to

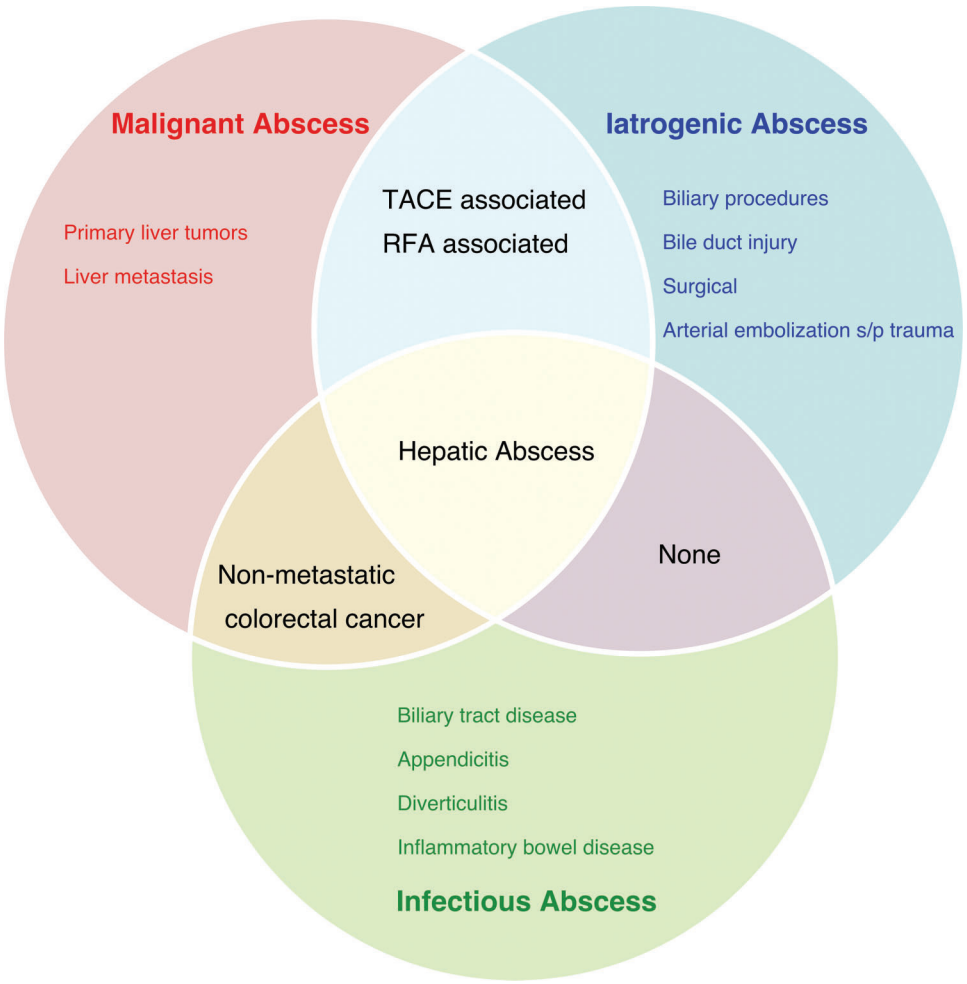

Fig. 1. The gray areas. Fig. 1 depicts a comparison of the sub-groups of HA and also delineates the areas of overlap between them.

proliferation of bacteria in the biliary tract, ascending cholangitis, and invasion of the liver parenchyma.

Although many types of bacteria have been identified in HAs, there have been several microbiological trends. Prior to 1980, *Escherichia coli* was the most common pathogen in HA worldwide.[3,15] Currently, this trend has shifted to *Klebsiella pneumonia*, particularly in Asia, where it accounts for 50%–73% of cases.[3,16,29] This may be related to the association of HA with DM. Diabetic patients are more susceptible to *K. pneumonia* infections.[19,21,34] *Clostridium perfringens* has also been reported in the literature more frequently, but it is still a rare cause of HA.[20] Depending on the primary source of infection, multiple organisms can be involved in HA.[9] Eltawansy *et al.* reported the presence of mixed organisms in 14%–55% of cases.[20]

Malignant Abscess

Malignant abscesses can be divided into three subcategories: secondary infection of a primary liver tumor, secondary infection of a metastatic liver lesion, and superinfection of spontaneous necrosis.

Secondary infection of primary liver tumor

Primary HCC can spontaneously develop in an area of central necrosis,[1] which can become infected with bacteria.[7,15] It is also possible for HCC to cause biliary obstruction,[7,15] potentially leading to ascending cholangitis and HA, as described above.

HA can be the initial manifestation of HCC.[15] These individuals tend to have a worse prognosis because the diagnosis of HA often delays the diagnosis of underlying HCC.[15] Some signs that were reported to be helpful in identifying superinfected malignancy included a thickened wall, the presence of septations, aerobilia, portal thrombosis, and gas within the abscess.[2,8]

Secondary infection of liver metastases

HA formation from liver metastasis is quite rare. A compilation of 1,262 cases of HA over 32 different studies found that only 3% were associated with hepatic metastasis.[9] However, in compiling these cases, it is possible that inclusion criteria may have differed between studies and skewed the results. There are a number of case reports of metastatic liver lesions

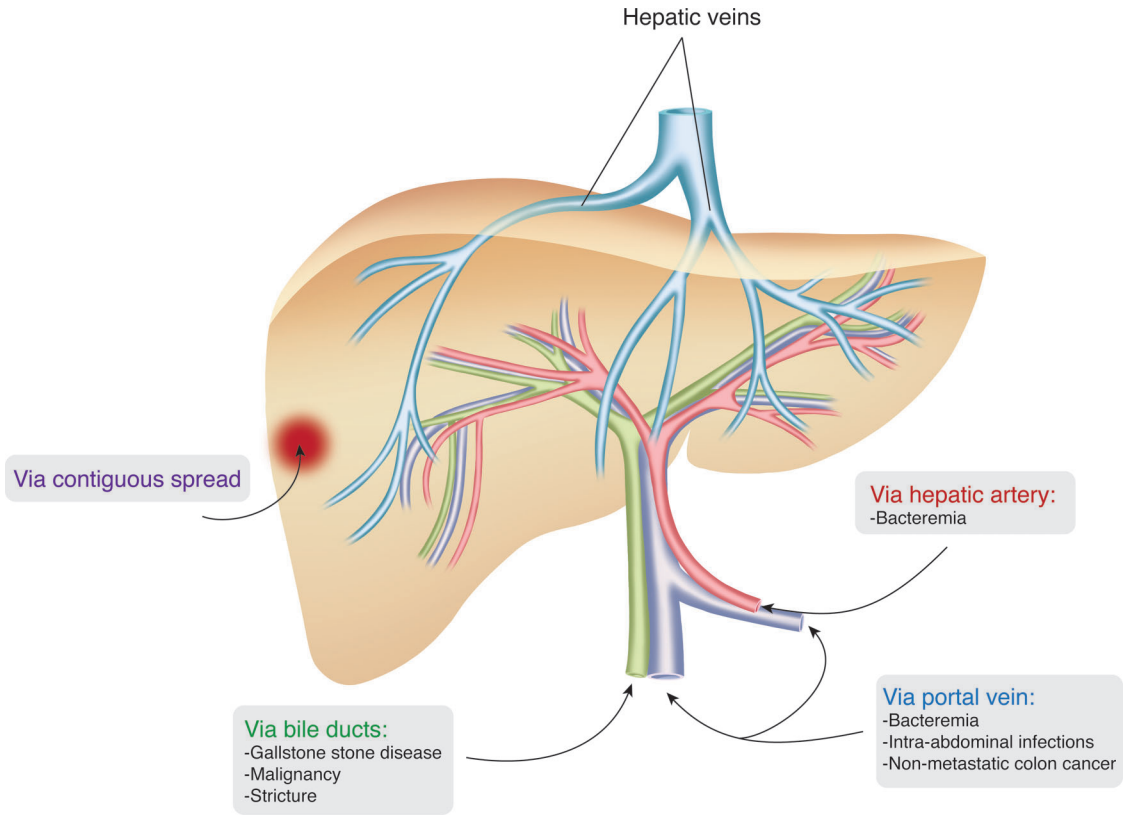

Fig. 2. Routes of infection.

arising from metastatic melanoma,[27] rectal cancer,[35] colon cancer,[31,36,37] esophageal carcinoma,[9,37] and pancreatic cancer[37,38] among others.

Superinfection of spontaneous necrosis

TACE and RFA are frequently used in the treatment of inoperable HCC[10,11,39] as well as liver metastasis. Both procedures induce necrosis of the tumor and some surrounding liver tissue. This area of necrosis may serve as a nidus for infection. In addition, some mechanisms specific to the TACE procedure predispose individuals to abscess formation. For example, TACE-induced necrosis suppresses reticuloendothelial cell activity, leading to decreased immunity.[11] There is also an immunosuppressant effect from the chemotherapeutic agents used.[39]

The incidence of HA has been reported to range from 0%–1.4% following TACE,[10,11] and 0.1%–0.7% following RFA.[12,13] The incidence increases in patients who have a pre-existing enterobiliary anastomosis (EBA).[12,13] In these patients, a dysfunctional sphincter of Oddi allows retrograde contamination of the biliary tract,[14] which occurs in 90% of patients with EBA.[14] For patients with previous EBA treated specifically with RFA, the incidence of HA increases up to 86%.[12] For these reasons, EBA may be a contraindication for TACE and RFA.[2] Given the significantly increased risk, less than 2% of patients who underwent RFA had pre-existing EBA in a large study by Elias *et al.*[13] Interestingly, this same study demonstrated that when EBA and RFA were done at the same time, there was no increased risk for HA formation.[13] However, this was a very small subgroup of the study with only four patients. In these four patients with RFA and EBA performed at the same time, no patients developed HA, presumably because peri-operative antibiotic coverage prevented biliary contamination and HA formation.[13]

Although the overall incidence of HA following TACE and RFA is low, the impact is increasing because of the increased use of ablative techniques for HCC palliation[39,40] and the increase in incidence of HCC.[41]

Given the known risk of HA in this situation, the effect of antibiotic prophylaxis for both TACE and RFA has been studied, but its role remains controversial.[10,13] Currently, there are no guidelines for prophylaxis before or during TACE.[10] Hoffman *et al.* found that only one out of the 10 patients with prior EBA undergoing RFA treatment developed HA after antibacterial prophylaxis.[14] These authors recommended antibiotic prophylaxis before RFA intervention plus a prolonged course for at least 10 days postprocedure.[14] However, given the small sample size, more convincing evidence is required to support the use of prophylaxis.

Shin *et al.* revealed that the time from TACE to diagnosis of HA ranged from 2–90 days, and the median survival time after this diagnosis was 6 months.[10] This finding illustrates the importance of monitoring patients for signs of infection post procedure and early detection and treatment of HA.

Iatrogenic Abscess

In addition to TACE and RFA, several other procedures have been associated with an increased risk of HA formation. The incidence of HA following biliary procedures has been

reported to be up to 26%.[2] Biliary stenting, sphincterotomy, and EBA are known to contaminate the biliary tract with bacteria,[38] allowing for ascending infection.[42] Matthews *et al.* reported that HA after a biliary procedure tended to be more indolent compared to those from biliary obstruction.[33]

Surgical procedures on the hepatobiliary system can disturb the liver's blood supply,[33] leading to ischemic necrosis. Similarly, arterial embolization used in the treatment of abdominal trauma can also cause ischemic necrosis of the liver and subsequent abscess formation.[2] In addition, complications of surgical procedures, such as biliary stricture, can result in secondary infection of susceptible tissues.[33]

Choledochoduodenostomy can be complicated by "sump syndrome,"[43] in which bile flow through a segment of the surgically altered common bile duct become stagnant.[43] This complication contributes to bacterial proliferation and predisposes patients to cholangitis and HA.[43]

Blunt trauma and some surgical procedures can produce hematomas in the liver. Although hematoma is a rare complication of laparoscopic cholecystectomy, Brown *et al.* described a case in which a large hematoma on computed tomography (CT) was found on postoperative day 6 with early signs of infection.[44] The development of hematoma during laparoscopic cholecystectomy may have been associated with prior use of nonsteroidal anti-inflammatory medications.[44]

Diagnosis

Because most of the symptoms of HA are due to infection and are nonspecific,[2,17] it can be quite difficult to diagnose in a timely manner.

The most commonly reported signs and symptoms (Table 2) include fever in most but not all cases, abdominal pain, and hypotension.[2,5,16,17,45–47] The percentage of patients affected by each symptom encompasses a fairly wide range, which reflects the high degree variability in clinical findings.

The difficulty in making the diagnosis is also reflected in the reported delay in time of onset of symptoms to time of diagnosis, which on average is one week.[17]

Laboratory findings in patients with HA are also relatively nonspecific. The most common abnormalities (Table 3) are elevated white blood cell count (WBC), elevated C-reactive protein, hypoalbuminemia, elevated aspartate aminotransferase (AST), elevated alanine aminotransferase (ALT), elevated alkaline phosphatase (ALP), elevated gamma glutamyl transpeptidase (GGT), elevated bilirubin, and elevated international normalized ratio (INR).[17]

While laboratory testing alone is not diagnostic,[47] laboratory abnormalities usually prompt imaging studies that do lead to the diagnosis.

Diagnosis of HA is made by imaging in 90% of cases.[2] Imaging can also help identify the underlying cause in some cases.[2] The primary methods of diagnostic imaging are conventional ultrasound (US) and CT. Both methods carry a sensitivity of 96%–100% for detection of HA.[47] However, Lin *et al.* found that 25% of patients had equivocal results in the emergency department, and 14% had a false negative result on US.[25] HA are typically hypo-echoic on US and may have varying degrees of internal echogenicity depending on the presence of septations or gas (Fig. 3).[47]

When US is nondiagnostic, CT, magnetic resonance imaging (MRI), or contrast enhanced US (CEUS) should be used to make the diagnosis.[25] HAs have lower attenuation compared to normal liver tissue on noncontrast CT.[47] With intravenous (IV) iodinated contrast, CT can reveal rim enhancement and enhancing internal septations, if present, due to increased vascularity of the abscess wall and septa.[47] On MRI, HA will be hyperintense on T2-weighted images and hypointense on noncontrast T1-weighed images. Depending on the proteinaceous content of the HA, some may demonstrate hyperintense signal on noncontrast T1-weighted images. After the administration of gadolinium, HAs demonstrate similar enhancement characteristics seen with CT.

Although CEUS is not Food and Drug Administration (FDA)-approved for liver imaging in the United States, it can be useful

Table 2. Clinical findings

Signs and symptoms	
Malaise[16]	89%
Chills[47]	69%
Fever[17,46,47]	59%–90%
Tachycardia[17]	52%
Nausea[46,47]	43%–68%
Abdominal pain[16,17,46]	39%–84%
Vomiting[45,47]	30%–32%
Right pleural effusion[45]	28%
Weight loss[47]	26%
Jaundice[17,47]	19%–21%
Ascites[16,46]	18%–21%
Murphy's sign[16]	16%
Hepatomegaly[16,46]	16%–52%
Guarding[17]	14%
Respiratory distress[16]	13%
Hypotension[16,17,46]	13%–30%
Diarrhea[47]	11%
Anorexia[16]	11%

Table 3. Laboratory findings

Abnormal laboratory finding*	
C-reactive protein	100%
Hemoglobin	82%
Bilirubin	75%
GGT	75%
WBC	74%
ALT	73%
Albumin	73%
ALP	71%
AST	67%
INR	13%

*Adapted from Pang TC, Fung T, Samra J, Hugh TJ, Smith RC. Pyogenic liver abscess: an audit of 10 years' experience. World J Gastroenterol 2011;17:1622-1630. doi:10.3748/wjg.v17.i12.1622.

Abbreviations: ALP, alkaline phosphatase; ALT, alanine aminotransferase; AST, alanine aminotransferase; GGT, gamma glutamyl transpeptidase; INR, international normalized ratio; WBC, white blood cell count.

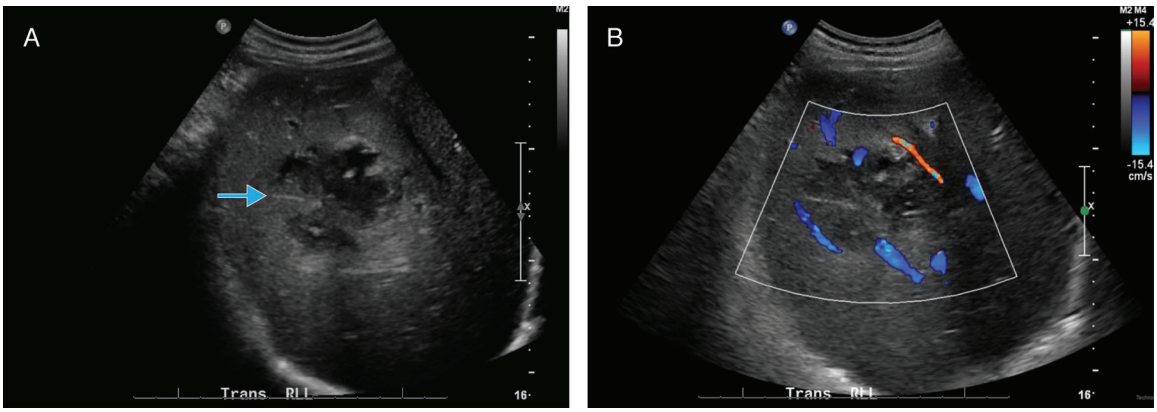

Fig. 3. Ultrasound (US). A. US demonstrates a hypoechoic abscess with heterogeneous echogenicity centrally consistent with septations and internal debris (blue arrow). B. Color Doppler US demonstrates peripheral hypervascularity surrounding the abscess cavity.

in the diagnosis of HA. CEUS is performed by injection of contrast medium through a peripheral IV line and subsequent views are taken through the arterial phase (10-30s post-injection), the portal phase (30-120s postinjection), and the late phase (> 120s postinjection).[48] Many studies have identified characteristic features of HA on CEUS, including rim enhancement in the arterial phase,[48,49] enhancement of septa creating a honeycomb appearance in loculated HAs,[48,49] and washout of the lesion during the late phase.[48] A study by Popescu *et al.* evaluated 41 patients with confirmed HA for these three findings using CEUS.[48] They concluded that CEUS yielded a "conclusive diagnosis" in 93% of cases and suggested that this method may be superior to conventional US.[48] However, by using only patients with a confirmed diagnosis of HA, this study was not well controlled. In contrast, Liu *et al.* examined patients with various focal liver lesions, including HA, infected granulomas, and inflammatory pseudotumors.[50] Like Popescu *et al.*, Liu *et al.* demonstrated the same three characteristic findings in HA, with 93.8% having rim enhancement, 68.8% showing septal enhancement, and 80.6% demonstrating late phase washout.[50] However, this study also found rim enhancement in 20% of infected granulomas and 50% of the pseudotumor cases.[50] Additionally, all of the infected granulomas and pseudotumors demonstrated late phase washout.[50] These latter findings make it difficult to use these three characteristics findings as criteria for a "definitive diagnosis" as suggested by Popescu *et al.* Although the diagnostic value of CEUS may be slightly overstated by some authors, it is well described in the literature as providing clearer images than conventional US.[51] CEUS allows for better visualization of the septations and consistency within the abscess,[48,49.,51] which may better inform selection of a treatment approach.

These imaging techniques also play a role in diagnostic US or CT-guided needle aspiration, which can confirm the diagnosis of HA as the material sampled during this procedure can be analyzed to determine the etiological agent. This procedure also plays a therapeutic role in percutaneous drainage, which will be discussed later.

Other important features that can be observed from imaging studies include location, size, number of abscesses, consistency, and presence of gas within the abscess. The right lobe of the liver is the most common location,[16,47] accounting for 68.7% of cases in one study.[16] Solitary abscesses (Fig. 4) are more common than multiple abscesses (Fig. 5), representing 67%–95% and 18%–32% of cases, respectively.[16,17,52] With regard to consistency, abscesses were solid in 58% of cases and cystic in 42% of cases.[52] Furthermore, gas was present in about 17% of cases.[52] These radiological features can help both with classification of HA and selection of the most appropriate treatment approach. Improvements in imaging techniques have led to more efficient diagnosis and decreased mortality.[53,54]

Treatment

Prior to 1980, treatment of HA primarily consisted of open surgical drainage.[54] However, percutaneous drainage (PD) has gained much popularity since its advent in 1953[55] and has emerged as the first line treatment for HA.[2,56] Smaller abscesses have even been managed medically with antibacterial therapy alone.[2,54] The development of effective antibiotics and advances in minimally invasive procedures by interventional radiology have largely been responsible for the decrease in mortality rate of HA.[17,52]

Medical management

Management with antibiotics alone has been shown to be effective for small abscesses, < 3–5 cm in diameter.[2] Hope *et al.* reported a 100% success rate for eight patients with unilocular abscess measuring < 3 cm in diameter with antibiotics alone.[54] In a larger study of 176 patients, an 81.2% success rate after antibacterial treatment was reported.[57] However, abscess characteristics, such as size and loculation, were not clearly stated in this group.

Biksup *et al.* proposed that smaller abscesses in difficult anatomical positions, such as in the caudate lobe, may be best treated conservatively due to the increased risks associated with invasive management.[58]

Antibacterial therapy should begin as soon as blood has been obtained for identification of organisms.[2] Patients are typically treated initially with IV antibiotics, followed by a course of oral (PO) antibiotics. Recommendations for duration range from 3 weeks IV plus 1–2 months PO to 2–3 weeks IV plus 1–2 weeks PO.[47] Treatment duration depends on both response to treatment, as determined by repeat US imaging, and resolution of fever and leukocytosis.[47]

Empiric coverage for gram-negative bacilli, gram-positive cocci, as well as anaerobic bacteria has been recommended.[2]

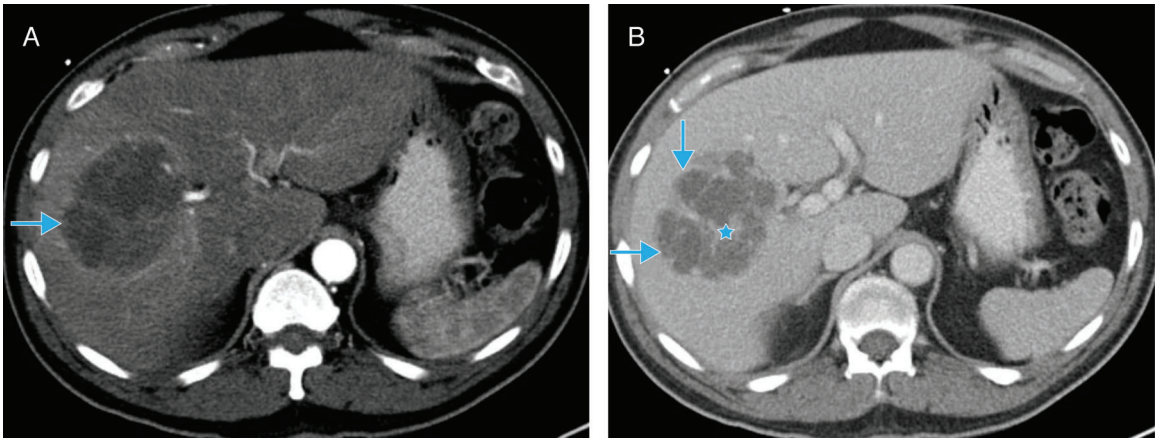

Fig. 4. Dynamic contrast-enhanced computed tomography (CT). A. Late arterial phase CT demonstrates hypervascular, peripheral enhancement of the abscess seen in Figure 4 (blue arrow). B. Portal venous phase CT demonstrates conspicuity of internally enhancing septations (blue star), likely representing intervening hepatic parenchyma. Note the multilocular nature of the abscess, which has implications for potential treatments (blue arrows).

This is usually accomplished with either a third-generation cephalosporin plus metronidazole or piperacillin/tazobactam.[47,53] However, some common pathogens associated with HA are resistant to both ampicillin and the fluoroquinolones.[47] Treatment is becoming complicated as the incidence of a hyperresistant *K. pneumonia* increases in some parts of the world.[47]

Interventional treatment

PD is the most commonly selected option for first-line treatment of HA. HA can be drained either with needle aspiration or by insertion of a pigtail catheter drain under US or CT guidance.[2] With percutaneous needle aspiration, a 16-18 Ga needle is inserted into the abscess cavity, and contents are aspirated until it is evacuated completely.[56] Similarly, during percutaneous catheter drainage, an 8-14 F pigtail catheter is inserted into the lesion and left in place.[56] It is then drained by gravity until empty.[56] Several studies have found percutaneous catheter drainage to be more effective than percutaneous needle aspiration, as it has higher success rates.[56,59]

PD carries many benefits, including being a minimally-invasive procedure,[53,54] obviating the need for general anesthesia.[53,54,60] It also has a lower risk of adhesion formation, contamination, and a relatively lower cost compared to surgical drainage (SD).[60]

It has been reported that PD fails in 15%–36% of cases.[17,45] There are a few possible reasons for these failures. HAs that are multiloculated can pose a challenge to drain all compartments.[53,54] In addition, HAs containing viscous fluid and necrotic tissue may be difficult to drain completely[45,53,54] due to blockage of the catheter.[45,53] Pang *et al.* found that hypoalbuminemia was a significant risk factor for PD failure.[17] The reason for this increase in risk is somewhat unclear. However, a low albumin level may indicate severity of any underlying sepsis.[17] In spite of its minimal invasiveness, PD has been reported to be complicated by hemorrhage and biliary fistulae.[17]

Surgical treatment

Surgery is indicated as the initial management for HA rupture,[53,54] peritonitis,[17] anatomically difficult access,[43,54] and co-existing pathology requiring surgery.[53,54] Initial surgical management may also be indicated for larger abscesses measuring > 3–5 cm in diameter.[53,54] However, some controversy remains in the literature regarding the best approach for treatment of large abscesses.

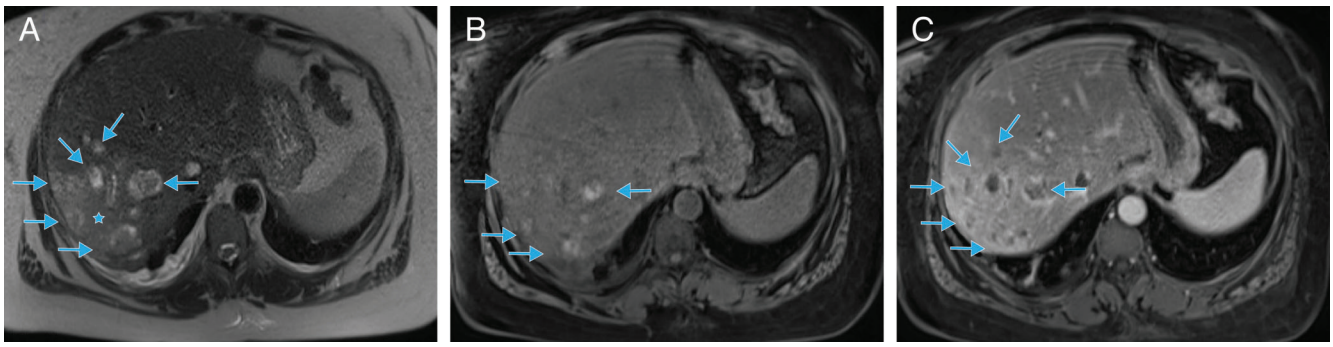

Fig. 5. Magnetic resonance imaging (MRI). A. T2-weighted image demonstrates multiple (at least six) small hyperintense abscess cavities in the right hepatic lobe (blue arrows). Note the hyperintense, edematous hepatic parenchyma (blue star). B. Noncontrast T1-weighted fat-sat image demonstrates varying degrees of T1 hyperintensity in the abscess cavities consistent with proteinaceous debris. C. Postcontrast T1-weighted fat-sat image demonstrates peripheral or rim enhancement around each of the abscesses.

Interventional versus surgical treatment

Since 2001, the number of interventional drainage procedures has more than doubled, while the number of surgical drainage procedures has decreased by about 20%.[60] Selection of a treatment method depends largely on the size and consistency of the abscess. One study of 48 patients with large (> 3 cm), unilocular abscesses treated with PD plus antibiotics reported an 83% success rate.[54] Large, multiloculated HAs treated with PD and antibiotics had only a 33% success rate, whereas a large multi-loculated group treated by SD was 100% successful.[54] Comparison of these findings with findings from similar studies is shown in Table 4. This study, among others, demonstrated better clinical outcomes with SD for patients with larger abscesses.[53,54] However, Ferraioli *et al.* demonstrated similar success rates of 95.4% and 93.4% for PD and SD, respectively.[46] Data for the SD group in Ferraioli's study was collected during an earlier time period (beginning in 1981) than the PD group (1998), and changes in medical imaging and management during this time may have impacted the results. In addition, both Ferraioli *et al.* and Tan *et al.* allocated patients to either a PD or SD group based on clinical judgment of the treating physician.[46,53] Hope *et al.* defined the study groups by abscess size alone.[54] This difference may account for some of the discrepancy in success rates between these three studies.

When selecting a treatment approach, it is important to consider the morbidity and mortality of these procedures. In the past, SD has been associated with a high mortality rate, ranging from 10%–47%.[56] One might expect this finding to be true as patients selected for surgery are typically those with larger abscesses, difficult anatomic access, multiple comorbidities, or other complicating factors. In comparing the modalities, many studies have found no significant difference in mortality between PD and SD.[46,53,54] However, Ferraioli *et al.* found that the SD group had a significantly higher morbidity (9.1%) compared to the PD group (0%).[46] In contrast, Tan *et al.* found no significant difference in morbidity between these two groups.[53] It is likely that the difference in sample size and relative distribution between treatment groups accounted for the different findings of these two studies.

Other considerations in selecting the treatment approach

In addition to abscess size and consistency, the type of abscess should be considered when choosing a treatment strategy (Fig. 6). Several reports recommended that iatrogenic abscesses due to surgical procedures should be treated surgically.[2] In addition, because malignant HAs containing necrotic tissue are at higher risk for PD failure,[45] malignant abscesses may be less likely to respond to PD. Nevertheless, because PD is minimally invasive, it might be reasonable to attempt PD if accessible, and only if unsuccessful, resort to SD.[46,47]

Complications

It has been reported that 15.7% of patients develop complications from HA.[16] This includes septic metastasis leading to extrahepatic complications, such as endopthalmitis,[16,61] septic pulmonary embolism,[52] infection of the lungs, central nervous system, and the eyes.[47] Abscess rupture is another reported complication,[16] with spontaneous rupture occurring in 6.1% of cases.[52] There was a higher reported incidence of HA rupture in abscesses infected with *Klebsiella* compared to other bacteria.[47] HAs can also erode the diaphragm, causing pleural effusion, empyema, pneumonia, pericarditis, bronchopleural fistulas, or duodenobronchofistulas.[36] Multiorgan failure can also occur as a consequence of HA.[16]

Table 4. Treatment success rates

Treatment			
Study	**Medical**	**Radiological**	**Surgical**
Alkofer *et al.*[45] 2011	70% n = 17 Mean diameter 3.7 cm	75.4% n = 57 Mean diameter 8.7 cm	91.6% n = 12 Mean diameter 9.14 cm
Ferraioli *et al.*[46] 2008	–	95.4% n = 108 Mean diameter 5.1 cm	93.2% n = 44 Mean diameter 5.3 cm
Hope *et al.*[54] 2008	100% n = 8 Diameter < 3 cm	83% n = 48 Diameter > 3 cm Uni-locular 33% n = 24 Diameter > 3 cm Multilocular	100% n = 27 Diameter > 3 cm Multi-locular
Tan *et al.*[53] 2005	–	72.2% n = 36 Diameter > 5 cm	93.8% n = 44 Diameter > 5 cm
Bamberger *et al.*[57] 1996	81.2% n = 176	–	–

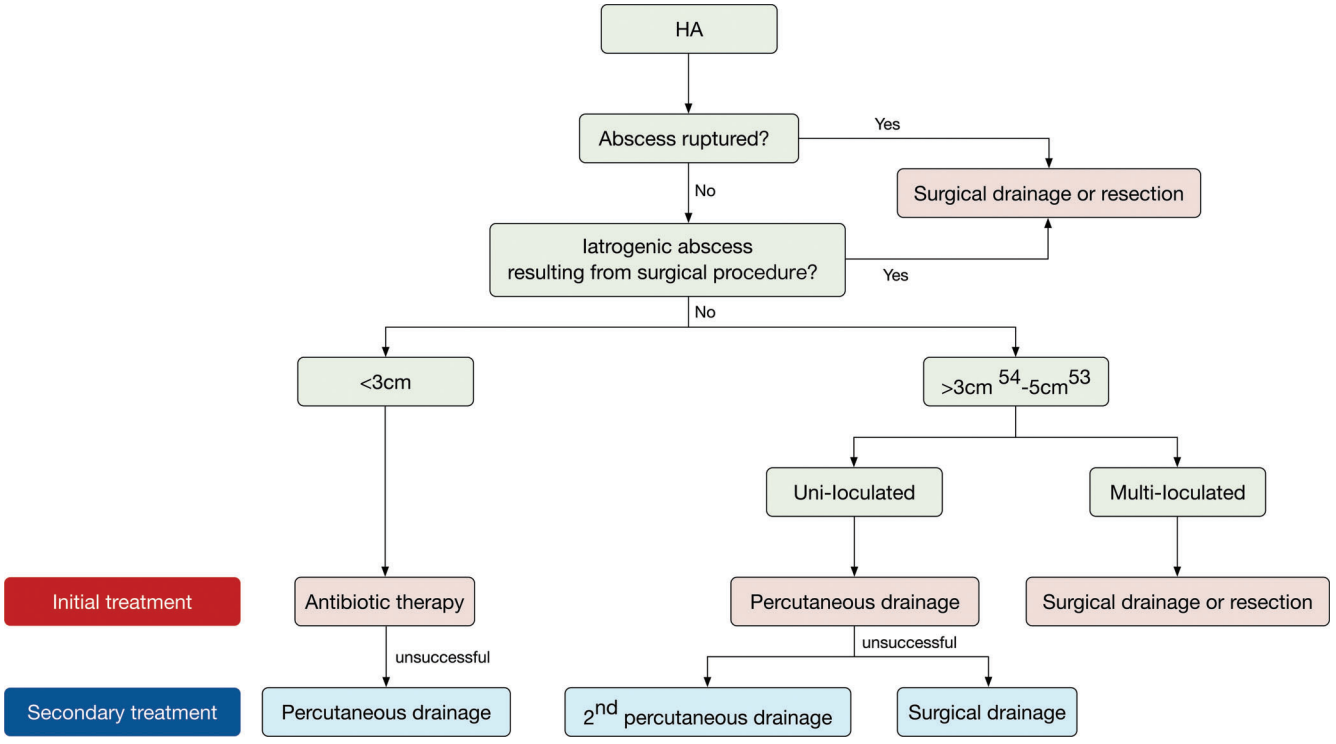

Fig. 6. Treatment strategies of HA*.

*Adapted from Hope WW, Vrochides DV, Newcomb WL, Mayo-Smith WW, Iannitti DA. Optimal treatment of hepatic abscess. Am Surg 2008;74:178-182.

Conclusions

Despite its low incidence, HA is associated with a relatively high mortality rate and several serious complications. For these reasons, prompt recognition is important in instituting effective management and achieving good outcomes. Because of the nonspecific symptoms and laboratory findings, the presence of predisposing factors can be helpful in increasing the level of diagnostic suspicion. Radiological features can help with both classification of HA and selection of the most appropriate treatment approach. Depending on its characteristics, HA can be effectively treated by either PD or SD in combination with antibiotics. The key to successful outcomes with both approaches is early diagnosis and institution of appropriate therapy. More prospective trials with large cohorts are needed to refine our understanding of this serious condition.

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Conflict of interest

None

Author contributions

Drafted the manuscript (MGM), analyzed the images for figures and revisions (MM), proposed the concept of the review and revised the manuscript with critical revisions (GYW).

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