

CLINICAL MICROBIOLOGY

# Microbiology of liver and spleen abscesses

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To study the aerobic and anaerobic microbiology of liver and spleen abscesses and correlate the results with predisposing factors, potential causes and routes of infection, clinical and laboratory data of 48 patients with liver abscesses and 29 with spleen abscesses treated between 1970 and 1990 were reviewed retrospectively. In liver abscesses, a total of 116 isolates (2.4 isolates/specimen) was obtained; 43 were aerobic and facultative species (0.9 isolates/specimen) and 73 were anaerobic species or micro-aerophilic streptococci (1.5 isolates/specimen). Aerobic bacteria only were isolated from 12 (25%) abscesses, anaerobic bacteria only from eight (17%), and mixed aerobic and anaerobic bacteria from 28 (58%); polymicrobial infection was present in 38 (79%). The predominant aerobic and facultative isolates were *Escherichia coli* (11 isolates), *Streptococcus* group D (8), *Klebsiella pneumoniae* (5) and *Staphylococcus aureus* (4). The predominant anaerobes were *Peptostreptococcus* spp. (18 isolates), *Bacteroides* spp. (13), *Fusobacterium* spp. (10), *Clostridium* spp. (10) and *Prevotella* spp. (4). There were 12 isolates of micro-aerophilic streptococci. *S. aureus* and  $\beta$ -haemolytic streptococci were associated with trauma; *Streptococcus* group D, *K. pneumoniae* and *Clostridium* spp. with biliary disease; and *Bacteroides* spp. and *Clostridium* spp. with colonic disease. In splenic abscesses, a total of 56 isolates (1.9 isolates/specimen) was obtained; 23 were aerobic and facultative species (0.8 isolates/specimen), 31 were anaerobic species or micro-aerophilic streptococci (1.1 isolates/specimen) and two were *Candida albicans*. Aerobic bacteria only were isolated from nine (31%) abscesses, anaerobic bacteria from eight (28%), mixed aerobic and anaerobic bacteria from 10 (34%) and *C. albicans* in two (7%); polymicrobial infection was present in 16 (55%). The predominant aerobic and facultative isolates were *E. coli* (5 isolates), *Proteus mirabilis* (3), *Streptococcus* group D (3), *K. pneumoniae* (3) and *S. aureus* (4). The predominant anaerobes were *Peptostreptococcus* spp. (11 isolates), *Bacteroides* spp. (5), *Fusobacterium* spp. (3) and *Clostridium* spp. (3). *S. aureus*, *K. pneumoniae* and *Streptococcus* group D were associated with endocarditis, *E. coli* with urinary tract and abdominal infection, *Bacteroides* spp. and *Clostridium* spp. with abdominal infection and *Fusobacterium* spp. with respiratory infection.

## Introduction

Liver and spleen abscess are still potentially life-threatening diseases, despite advances in their diagnosis and treatment. The most common causes of liver abscess are biliary and colonic disease, haematogenous seeding, recent gastric or duodenal surgery, local trauma and pancreatitis [1–3]. Recent studies have emphasised the polymicrobial nature of these infections with Enterobacteriaceae, *Enterococcus* spp. and anaerobic bacteria being the predominant isolates [1–6].

However, no correlation was made in most of these studies between the microbial isolates and the predisposing conditions [2–6]. Furthermore, the methods for isolation of anaerobic bacteria were either not specified or inadequate, which may have resulted in a failure to isolate all anaerobes present and incomplete identification of the organisms isolated [2–5]. The most common predisposing causes of splenic abscess are pyogenic infection, splenic trauma, haemoglobinopathies and contiguous disease processes extending to the spleen [7]. Staphylococci (primarily *Staphylococcus aureus*) and gram-negative aerobic bacteria are the most frequently reported isolates [7–11]. Polymicrobial flora are cultured from at least 10–15% of patients [7–11]. The reported frequency of negative culture may be up to 30% [7], which may reflect prior antibiotic

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therapy, sterile necrosis following infarction, or failure to culture properly for anaerobic and other fastidious organisms. This retrospective report describes the 20-year experience in a military hospital of the diagnosis of the bacterial causes of liver and spleen abscesses.

## Patients and methods

### Patients

Between June 1970 and June 1990, bacteria were isolated from 48 specimens from adult patients with pyogenic liver abscess and from 29 specimens from patients with splenic abscess submitted to the clinical microbiology laboratory at the Naval Hospital in Bethesda, MD, USA.

*Liver abscess.* Pyogenic liver abscess was defined as one or more discrete lesions in the liver in association with positive bacterial culture of material obtained at operation or by percutaneous aspiration. Patients with amoebic or other parasitic liver abscess were excluded. Also excluded were a further nine specimens for which no clinical data were available, five specimens that showed no bacterial growth, and three specimens that were submitted in inadequate transport media for anaerobes. Clinical and microbiological data were compiled for the 48 patients of whom 23 were men; the ages of patients were in the range 23–78 years (mean 56 years).

*Splenic abscess.* Splenic abscess was defined as an infectious suppurative process involving an identifiable filling defect either in the parenchyma of the spleen or in the subcapsular space. Excluded were another three splenic abscess specimens for which no clinical data were available, three that showed no bacterial growth, and two that were submitted in inadequate transport media for anaerobes. Clinical and microbiological data were compiled for the 29 patients of whom 18 were men; the ages of patients were in the range 17–81 years (mean 50 years).

Antimicrobial therapy was given to all patients with liver abscesses and all but six with splenic abscesses before sample collection. The most frequently used antimicrobial agents were amoxycillin, cefoxitin and aminoglycosides. Specimens were obtained at surgery by a swab or by percutaneous needle aspiration. The swab was placed into anaerobic transport medium (Port-Cul; BBL Microbiological Systems, Cockeysville, MD, USA) and cultures were generally inoculated within 2 h of collection. Needle aspiration was performed with an 18- or 20-gauge needle attached to a 5- or 10-ml syringe. The syringe was immediately sealed and was usually transported to the laboratory within 30 min of collection.

### Microbiological investigations

Sheep blood agar, chocolate agar and MacConkey agar plates were inoculated for the isolation of aerobic

organisms. The plates were incubated at 37°C aerobically (MacConkey agar) or in air with CO<sub>2</sub> 5% (blood and chocolate agar) and examined after 24 and 48 h. For the isolation of anaerobes, specimens were plated on to prereduced phytonadione-enriched *Bruccella* blood agar, anaerobic blood agar containing kanamycin sulphate and vancomycin hydrochloride, and anaerobic blood agar containing colistin and nalidixic acid, and then the swab was placed in enriched thioglycollate broth. The agar media were incubated in anaerobic jars (BBL Microbiological Systems) and examined after 48, 96 and 120 h. No antimicrobial susceptibility testing of anaerobic isolates was done. The thioglycollate broth was incubated for 14 days and was subcultured on to all the above media if no growth was obtained in the original cultures. Aerobic and anaerobic bacteria were identified by techniques described previously [12–14].

Blood for culture was drawn from 36 patients with liver abscess and 24 with splenic abscess, most often from an antecubital vein, after preparation of the area with povidone-iodine, and inoculated at the bedside into two bottles, one supportive of growth of aerobic bacteria and the other supportive of anaerobic bacteria.

## Results

### Liver abscess

*Microbiology.* A total of 116 isolates (2.4/specimen) was obtained from the 48 abscesses; 43 were aerobic and facultative species (0.9 isolates/specimen) and 73 (1.5/specimen) were anaerobes or micro-aerophilic streptococci (Table 1). Aerobic bacteria only were isolated from 12 (25%) of the abscesses, anaerobic bacteria only from eight (17%) and mixed aerobic and anaerobic bacteria from 28 (58%). Polymicrobial infection was present in 38 (79%) abscesses and, in these, the number of isolates varied from two to five.

The predominant aerobic and facultative isolates were *Escherichia coli* (11 isolates), *Streptococcus* group D (8), *Klebsiella pneumoniae* (5),  $\alpha$ -haemolytic streptococci (5), *S. aureus* (4) and  $\beta$ -haemolytic streptococci (three; two of group A and one of group F). The predominant anaerobes were: *Peptostreptococcus* spp. (18 isolates) that included *P. micros* (7), *P. prevotii* (4), *P. anaerobius* (3), *P. magnus* (2) and *P. asaccharolyticus* (2); *Bacteroides* spp. (13) that included *B. fragilis* (7), *B. thetaiotaomicron* (3), *B. vulgatus* (2) and *B. distasonis* (1); *Fusobacterium* spp. (10) that included *F. nucleatum* (5), *F. mortiferum* (1) and *F. necrophorum* (1); *Clostridium* spp. (10) that included *C. perfringens* (5), *C. ramosum* (2) and *C. septicum* (2); *Prevotella* spp. (4) that included *Pr. intermedia* (2), *Pr. melaninogenica* (1) and *Pr. disiensis* (1). There were 12 isolates of micro-aerophilic streptococci – *Str. intermedius* (3), *Str. constellatus* (3) and *Gemella morbillorum* (2).

Table 1. Correlation between the microbiology of 48 liver abscesses and predisposing conditions

Organisms isolated*	Number of isolates associated with										Total isolates
	biliary disease		colonic disease		haematogenous seeding (4)	local trauma (4)	pancreatitis (2)	recent gastric or duodenal surgery (7)	unknown (8)		
	benign (5)	malignant (5)	benign (9)	malignant (4)							
<b>Aerobic</b>											
<i>α</i> -Haemolytic streptococci		1	1	1				1	1		5
<i>β</i> -Haemolytic streptococci†		2				2					3
<i>Streptococcus</i> group D	4				1		1	1			8
<i>S. aureus</i>			3	2 (1)	1 (1)	3 (1)					4 (2)
<i>E. coli</i>	1	1 (1)			1			1 (1)			11 (5)
<i>K. pneumoniae</i>		2 (2)				1		1			5 (2)
<i>Pseudomonas aeruginosa</i>				1							2
<i>Prot. mirabilis</i>				1							2
<i>Serratia marcescens</i>				1							3
Subtotal	5	6 (3)	4	5 (1)	2 (1)	6 (1)	3 (1)	1	7 (2)	5	43 (9)
<b>Anaerobic</b>											
<i>Peptostreptococcus</i> spp.	2	3	3	1	1 (1)	1	1	1	3		18 (1)
Micro-aerophilic streptococci	2	2	1	1	3	1	1	1	1		12
<i>Prop. acnes</i>					1	1			1		3
<i>Veillonella parvula</i>			1	1				1			3
<i>Clostridium</i> spp.	2	1	3	2 (2)	1	1					10 (2)
<i>Fusobacterium</i> spp.				2 (1)	2			2	4 (1)		10 (2)
<i>Bacteroides</i> spp.	1		5	2 (1)			1	2 (1)	2 (1)		13 (3)
<i>Prevotella</i> spp.					1	1		1	1		4
Subtotal	7	6	13	9 (4)	9 (1)	5	3	10 (1)	11 (2)		73 (8)
Total	12	12 (3)	17	14 (5)	11 (2)	11 (1)	6 (1)	17 (3)	16 (2)		116 (17)

\*Organisms isolated from blood are shown in parentheses.

†Group A (2), group F (1).

Seventeen isolates similar to those isolated from the abscesses were also cultured from 14 (39%) of the 36 cases in which blood cultures were collected (Table 1).

Some relationships between the organisms isolated and the potential causes and routes of infection were noted (Table 1). *S. aureus* and  $\beta$ -haemolytic streptococci were mostly associated with trauma, *Streptococcus* group D and *K. pneumoniae* with biliary disease, *Bacteroides* spp. with colonic disease, and *Clostridium* spp. with colonic and biliary diseases. There was no correlation between the microbiological findings and the presence of a solitary (37 cases) or multiple abscesses (11 cases) or the location of the solitary abscesses.

*Management and outcome.* Antimicrobial therapy was given to all patients and surgical drainage was performed in 41 (85%). The antimicrobial agents used were an aminoglycoside (43 cases), clindamycin (20), metronidazole (15), amoxicillin (12), cefoxitin (5), methicillin (5), vancomycin (4), ceftazidime (3), imipenem-cilastatin (3), ticarcillin-clavulanate (2) and cefazolin (1). Three of the patients died from their infection; one had a pancreatic carcinoma, one a colonic carcinoma and *E. coli* sepsis, and one had gangrenous cholecystitis and colon perforation.

### Spleen abscesses

*Microbiology.* A total of 56 isolates (1.9/specimen) was obtained from 29 abscesses; 23 were aerobic and facultative species (0.8 isolates/specimen), 31 (1.1/specimen) were anaerobes (or micro-aerophilic streptococci) and two were *Candida albicans* (Table 2). Aerobic bacteria only were isolated from nine (31%) of the abscesses, anaerobic bacteria only from eight (28%), mixed aerobic and anaerobic bacteria from 10 (34%) and *C. albicans* from two (7%). Polymicrobial infection was present in 16 (55%) abscesses and in these the number of isolates varied from two to five.

The predominant aerobic and facultative bacteria were *E. coli* (5 isolates), *S. aureus* (4), and *Streptococcus* group D, *K. pneumoniae* and *Proteus mirabilis* (3 each). The predominant anaerobic bacteria were: *Peptostreptococcus* spp. (11 isolates) that included *P. magnus* (3), *P. micros* (2), *P. prevotii* (2), *P. anaerobius* (1) and *P. asaccharolyticus* (1); *Bacteroides* spp. (5) that included *B. fragilis* (2), *B. vulgatus* (2) and *B. thetaiotaomicron* (1); *Clostridium* spp. (3) that included *C. perfringens* (2) and *C. ramosum* (1); *Prevotella* spp. (3) that included *Pr. intermedia* (2) and *Pr. melaninogenica* (1); *F. nucleatum* (3); and *Propionibacterium acnes* (3).

Seventeen isolates similar to those isolated from the abscesses were also cultured from 13 (54%) of the 24

patients from whom blood cultures were collected (Table 1).

Some relationships between the isolates and the predisposing condition were noted (Table 2). *S. aureus*, *K. pneumoniae* and *Streptococcus* group D were mostly associated with endocarditis, *E. coli* with urinary tract and abdominal infections, *Bacteroides* spp. and *Clostridium* spp. with abdominal infection, *Fusobacterium* spp. with respiratory tract infection and *C. albicans* with cancer and chemotherapy.

*Management and outcome.* All patients received antimicrobial therapy in association with splenectomy. The antimicrobial agents used were aminoglycosides (19 cases), methicillin (8), clindamycin (8), ceftazidime (6), amoxicillin (3), cefoxitin (3), imipenem-cilastatin (3), metronidazole (2), vancomycin (2), ticarcillin-clavulanate (2), ciprofloxacin (2), ceftriaxone (2), cefotaxime (2) and amphotericin-B (2). Three patients died from their infection; one patient had monocytic leukaemia and *C. albicans* abscesses and sepsis, one a generalised peritonitis and myocardial infarction, and one had endocarditis due to *S. aureus*.

### Discussion

This study demonstrates the isolation of aerobic and anaerobic bacteria from liver and spleen abscesses. Organisms similar to those isolated in this study from liver abscesses have been reported by other investigators [2–6]. However, in contrast to previous reports, anaerobic bacteria were isolated more frequently from liver abscesses and their isolation was associated with colonic and biliary origins.

This study also confirms previous reports of splenic abscesses [7–11] where *S. aureus*, *K. pneumoniae* and *Streptococcus* group D were isolated from abscesses associated with endocarditis and *E. coli* was isolated in association with urinary tract or intra-abdominal infections. This study also emphasises the importance of anaerobic bacteria in polymicrobial splenic abscesses. As was demonstrated in previous studies [7–11], the isolation of these organisms correlates with predisposing factors that allow the dissemination of anaerobic bacteria from another infected site to the spleen. These infections can be either chronic respiratory infections caused by anaerobic bacteria, such as retropharyngeal abscess, or abdominal infection.

The high isolation rate of anaerobic bacteria in this series may be the result of the particular efforts made to use proper methods of collection and transportation of specimens and the inclusion in the report only of specimens specifically submitted for culture for both aerobic and anaerobic bacteria. Many of the previous studies did not use such methods.

Table 2. Correlation between the microbiology of 29 splenic abscesses and predisposing conditions

Organisms	Numbers of isolates associated with								Total isolates
	endocarditis (6)	urinary tract infection (3)	intra-abdominal focus (7)	respiratory tract (3)	trauma (3)	haemaglobinopathy (1)	cancer/chemotherapy (4)	unknown (2)	
<i>Candida albicans</i>							2 (1)		2 (1)
Aerobic bacteria									
$\alpha$ -Haemolytic streptococci	1 (1)	1							2 (1)
$\beta$ -Haemolytic streptococci	2 (2)		1	1					3 (2)
Streptococcus group D	2 (2)				1			1 (1)	4 (3)
<i>S. aureus</i>		3 (1)	2 (1)	1 (1)					5 (2)
<i>E. coli</i>	2 (1)								3 (2)
<i>K. pneumoniae</i>							1 (1)		1 (1)
<i>Pseudomonas aeruginosa</i>		2			1				3
<i>Prot. mirabilis</i>						1			1
<i>Salmonella typhi</i>		6 (1)	3 (1)	2 (1)	2	1	1 (1)	1 (1)	23 (11)
Subtotal	7 (6)								
Anaerobic bacteria									
<i>Peptostreptococcus</i> spp.	1		4	2 (1)	2		1	1	11 (1)
Micro-aerophilic streptococci	1			1					2
<i>Prop. acnes</i>			1		1				3
<i>Veillonella parvula</i>							1		1
<i>Clostridium</i> spp.			2 (1)	2 (1)	1				3 (1)
<i>Fusobacterium</i> spp.			4 (2)					1	3 (1)
<i>Bacteroides</i> spp.			1	1			1		5 (2)
<i>Prevotella</i> spp.	2		12 (3)	6 (2)	4	1	4	2	31 (5)
Subtotal	9 (6)	6 (1)	15 (4)	8 (3)	6	2	7 (1)	3 (1)	56 (17)
Total									

\* Organisms also isolated from blood are shown in parentheses.

Because anaerobes are the predominant organisms present in the normal flora of the oral cavity and the gastrointestinal tract, outnumbering aerobes at a ratio of at least 100 to 1 in the oropharynx [15] and 1000 to 1 in the colon [16], their predominance in abscesses that originate from these flora is not surprising. The liver and spleen may be invaded by pyogenic microorganisms in several ways. Embolic abscesses, usually multiple, may originate from foci anywhere in the body *via* the arterial route. Direct extension of infection, or extension by way of the lymphatics, may develop from infected intra-abdominal sites such as appendicitis, diverticulitis, perforated bowel or pelvic infection. Extrahepatic biliary obstruction and cholangitis may cause liver abscess. Occasionally, an abscess may follow penetrating or blunt trauma.

Pyogenic liver abscesses may require percutaneous aspiration to aid in the microbiological diagnosis and to guide antibiotic therapy [17]. As a result of the development of better imaging techniques for guidance, open surgical drainage is now rarely necessary. However, care must be taken to avoid puncture of vital intra-abdominal structures and percutaneous aspiration should not be done when contra-indicated, e.g., in bleeding disorders, amoebic abscesses, or small multiple abscesses. Antimicrobial therapy should be based on the microbiological information, but if the patient's condition is unstable or fails to respond to antimicrobial therapy, surgical drainage should be performed. Evacuation of the abscess activity serves two major purposes: to obtain good bacteriological specimens to enable maximal antibiotic efficiency; and to remove and prevent local spread of purulent material. Appropriate broad-spectrum antibiotics should also be started parenterally and continued for at least 4–6 weeks. A careful attempt should be made to identify the causative micro-organisms, including anaerobes, and as many of the isolated anaerobic bacteria produce  $\beta$ -lactamase and are resistant to penicillins [18], antimicrobial agents effective against these organisms should be used. If anaerobic organisms are isolated, metronidazole, clindamycin, imipenem, ceftioxin or the combination of a penicillin and a  $\beta$ -lactamase inhibitor are the drugs of choice [19–20]. Metronidazole is also a very potent amoebicide. An aminoglycoside, a quinolone, or a third-generation cephalosporin should be added if gram-negative enteric bacteria are present, and if *S. aureus* is present, anti-staphylococcal agents should be used. Antimicrobial agents, especially when used without surgical drainage, should be given for at least 6–8 weeks. A shorter course, of 4–6 weeks, may be used when good surgical drainage has been achieved, but

more precise recommendations for the treatment of liver and spleen abscesses have not yet been determined in prospective studies.

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