CASE REPORT

BARTONELLA HENSELAE: FIRST REPORTED ISOLATE IN A HUMAN IN THAILAND

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Abstract. This is the first reported case of bacillary angiomatosis associated with *Bartonella henselae* in Thailand. The clinical, pathological, and microbiological findings are presented. The bacterium was isolated from a biopsy of skin lesions obtained on admission and identified by cellular morphology, characteristics of colonies on chocolate agar, extensive biochemical tests and 16S ribosomal DNA sequencing.

INTRODUCTION

Bartonella is a genus of slow-growing, fastidious gram-negative bacteria that may necessitate a month or longer for culture isolation depending on species and individual isolates (Berbari *et al*, 1997). The genus now includes several species because all the members of the genus *Rochalimaea* were transferred into this genus (Winn *et al*, 2006). Studies conducted over the past 10 to 15 years establish that *Bartonella* constitutes a unique group of bacteria found in a wide variety of wild and domestic animals. These animals may be asymptomatic or may develop significant disease, including chronic bacteremia. Infected animals serve as reservoirs and potential sources for additional animal and human infections (Breitschweerdt and Kordick, 2000). *B. henselae* (formerly *Rochalimaea henselae*) is the organism which causes bacillary angi-

omatosis (BA) in immunocompromised patients and cat-scratch disease in immunocompetent patients. BA is characterized by the eruption of cutaneous and subcutaneous nodules. As the number of lesions increases, patients may develop fever, sweats, chills, poor appetite, vomiting or weight loss. If untreated, patients may die from the complications of this disease. It is often misdiagnosed because it may be mistaken for other conditions such as Kaposi sarcoma. BA can cause blood vessels to grow out of control and form tumor-like masses in skin, bone, liver and other organs. *B. henselae* is globally endemic; serologic studies indicate that infection of domestic cats is worldwide, with the prevalence of antibodies being higher in warm, humid climates (Slater and David, 2005). *B. henselae* can multiply prodigiously in the cat flea, and the organism can remain viable in flea feces for at least 3 days (Finkelstein *et al*, 2002; Winn *et al*, 2006). Some reports from Thailand showed that *B. henselae* was isolated from domestic cats and cat fleas but no isolates were found in humans (Maruyama *et al*, 2001; Parola *et al*, 2003). We report a case of BA caused by

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B. henselae which was identified from skin lesions.

CASE REPORT

A 40-year-old woman from Myanmar was diagnosed as having symptomatic HIV infection with CMV retinitis for 3 years. Her CD4 cell count was 11 cells/mm³. She was given stavudine, lamivudine and nevirapine but her adherence to the regimen was poor. Nine months before this admission in August, 2006 she stopped her antiretroviral therapy because she went back to her country. The CD4 cell count before stopping was 178 cells/mm³. This time she came to Rajavithi Hospital because she had prolonged fever for 2 months and had lost 10 kilograms. One week prior to admission the fever increased and she noticed multiple red nodules on her face and over her entire body (Fig 1). She denied cat exposure, however, she had walked across the Thai-Myanmar border and stayed in the jungle for some nights.

Blood tests indicated a hemoglobin level of 9.7 g/dl, hematocrit of 29.1%, white blood cell count of 4,600/µl, and platelet count of 7,000/µl. The liver function test revealed an elevated alkaline phosphatase of 440 U/l (normal range; 39-117 U/l), but other tests were normal. A skin biopsy was done for pathological examination and culture. The pathology revealed nodules consisting of lobules of capillaries lined by a plump endothelium with clear cytoplasm. Mild atypia and occasional mitotic figures were present. The interstitium contained a neutrophilic infiltrate and nuclear debris. Warthin-Starry silver stain showed clumped rod-shaped organisms. BA was diagnosed and doxycycline prescribed. The lesions responded to the doxycycline. Within 2 weeks the lesions were inactive (Fig 2), and the platelet counts returned to normal at 6-weeks follow-up. Skin biopsies, bone marrow and blood cultures were collected to identify

Fig 1–The patient before treatment (with permission from the patient).

Fig 2–Two weeks after treatment.

the pathogenic bacteria using standard microbiological techniques (Thomson and Miller; 2003). For the skin biopsy and bone marrow, a conventional culture method was used. For the blood culture, the patient's blood (8-10 ml) was inoculated into the automate Bactec system (Becton Dickinson, USA), resin containing media, in order to enhance isolation of pathogenic bacteria.

Organism identification and sequencing of 16S rDNA

The skin culture yielded a pure growth of bacteria on chocolate agar after 7 days of incubation at 35ºC in a 5% carbon dioxide incubator. The colonies were translucent, colorless, and circular, approximately 0.5 mm in diameter (Fig 3). The organism was a typically capnophilic bacteria (growth required a higher-than-atmospheric level of carbon dioxide), because it did not grow in an ambient incu-

Fig 3–*Bartonella henselae* tiny colonies on choco-
late agar after 7 days of incubation at 35ºC
in the 5% carbon dioxide incubator.

bator. The organism did not grow on blood
agar or MacConkey agar after 10 days of in-
cubation at 35ºC in a 5% carbon dioxide in-
cubator. A Gram stain of the colonies from the
chocolate agar revealed small gram-negative
bacilli with pleomorphism (coccobacilli, plump
or slightly curved rods). The results of the
blood culture (13 total specimens) and bone
marrow culture (1 specimen) from this patient
were negative.

On biochemical tests, we found *B.
henselae* has inert properties. It was negative
on oxidase, catalase, urease, arginine
dihydrolase, ornithine decarboxylase, and ni-
trate reductase tests. The various sugar fer-
mentations in cysteine trypticase agar (CTA)
ie, glucose, inositol, lactose, maltose, man-
nose, mannitol, raffinose, salicin, sorbitol, su-
crose, trehalose, and xylose were negative.
The substrate digestion of esculin and gelatin
were also negative. The growth study on triple
sugar iron agar, in 6.5% sodium chloride broth,
or tryptone broth was negative. Sugar fermen-
tation, substrate digestion and growth stud-
ies, were also tried by adding a few drops of
sterile horse serum (Gibco, USA) into various
media as a growth supplement for enrichment.
However, the results were also negative.

Based on cellular morphology and biochemi-
cal tests described previously (Welch and
Slater; 2003), our organism was identified as
Bartonella species. In our clinical microbiol-
ogy laboratory, the commercial identification
system used for non-fermentative bacteria (the
API 20 NE) and the automate Vitek II system
(both from bioMerieux, France) were available
but they do not contain *Bartonella* in their da-
tabase.

We attempted to confirm the identifica-
tion of this organism by molecular technique
using sequencing of 16S rDNA. Extraction of
the bacterial genomic DNA, amplification of
the 16S rDNA by polymerase chain reaction,
and subsequent sequencing of the amplicons
were performed as described previously
(Edwards *et al*, 1989; Eden *et al*, 1991;
Weisburg *et al*, 1991; Kolbert *et a*l, 2004). This
strain was amplified and sequenced, and the
sequence data of 978 base pairs were que-
ried to the GenBank for best matches. The
homology search result confirmed this organ-
ism as *B. henselae*, as shown in Fig 4.

DISCUSSION

BA is a systemic disease first described
in a 32-year-old patient with presumed ac-
quired immunodeficiency syndrome (AIDS)
who developed multiple subcutaneous nod-
ules characterized histologically by vascular
proliferation. Bacillary forms were demon-
strated, and the patient responded to eryth-
romycin with an apparent cure (Stoler *et al*,
1983). Later, in a report that stimulated wide-
spread attention to BA, 6 AIDS patients de-
veloped unusual cutaneous papules and nod-
ules distinct from Kaposi sarcoma (Cockerell
et al, 1987). The researchers, being unaware
of its infectious origin, called the lesion
epitheloid angiomatosis. This name was se-
lected because the deeper dermis has alter-
ations similar to those of epitheloid heman-
giomas, with endothelial cells adherent to one

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                    *        20        *        40        *        60        *        80
BhsM40SHD : AGAGTTTGATCCTGGCTCAGAACGAACGCTGGCGGCAGGCTTAACACATGCAAGTCGAGCGCACTCTTTTAGAGTGAGCG
Th_Bhens  : --------------------------------------------------------------------------------
                    *       100        *       120        *       140        *       160
BhsM40SHD : GCAAACGGGTGAGTAACGCGTGGGAATCTACCCATCTCTACGGAATAACACAGAGAAATTTGTGCTAATACCGTATACGT
Th_Bhens  : --------------------------------------------------------------------------------
                    *       180        *       200        *       220        *       240
BhsM40SHD : CCTTAGGGAGAAAGATTTATCGGAGATGGATGAGCCCGCGTTGGATTAGCTAGTTGGTGAGGTAACGGCTCACCAAGGCG
Th_Bhens  : --------------------------------------------------------------------------------
                    *       260        *       280        *       300        *       320
BhsM40SHD : ACGATCCATAGCTGGTCTGAGAGGATGATCAGCCACACTGGGACTGAGACACGGCCCAGACTCCTACGGGAGGCAGCAGT
Th_Bhens  : --------------------------------------------------------------------------------
                    *       340        *       360        *       380        *       400
BhsM40SHD : GGGGAATATTGGACAATGGGGGCAACCCTGATCCAGCCATGCCGCGTGAGTGATGAAGGCCCTAGGGTTGTAAAGCTCTT
Th_Bhens  : ---------------ATGGGGGCAACCCTGATCCAGCCATGCCGCGTGAGTGATGAAGGCCCTAGGGTTGTAAAGCTCTT

                    *       420        *       440        *       460        *       480
BhsM40SHD : TCACCGGTGAAGATAATGACGGTAACCGGAGAAGAAGCCCCGGCTAACTTCGTGCCAGCAGCCGCGGTAATACGAAGGGG
Th_Bhens  : TCACCGGTGAAGATAATGACGGTAACCGGAGAAGAAGCCCCGGCTAACTTCGTGCCAGCAGCCGCGGTAATACGAAGGGG

                    *       500        *       520        *       540        *       560
BhsM40SHD : GCTAGCGTTGTTCGGATTTACTGGGCGTAAAGCGCATGTAGGCGGATATTTAAGTCAGAGGTGAAATCCCAGGGCTCAAC
Th_Bhens  : GCTAGCGTTGTTCGGATTTACTGGGCGTAAAGCGCATGTAGGCGGATATTTAAGTCAGAGGTGAAATCCCAGGGCTCAAC

                    *       580        *       600        *       620        *       640
BhsM40SHD : CCTGGAACTGCCTTTGATACTGGGTATCTTGAGTGTGGAAGAGGTGAGTGGAATTCCGAGTGTAGAGGTAAAATTCGTAG
Th_Bhens  : CCTGGAACTGCCTTTGATACTGGGTATCTTGAGTGTGGAAGAGGTGAGTGGAATTCCGAGTGTAGAGGTAAAATTCGTAG

                    *       660        *       680        *       700        *       720
BhsM40SHD : ATATTCGGAGGAACACCAGTGGCGAAGGCGGCTCACTGGTCCATTACTGACGCTGAGGTGCGAAAGCGTGGGGAGCAAAC
Th_Bhens  : ATATTCGGAGGAACACCAGTGGCGAAGGCGGCTCACTGGTCCATTACTGACGCTGAGGTGCGAAAGCGTGGGGAGCAAAC

                    *       740        *       760        *       780        *       800
BhsM40SHD : AGGATTAGATACCCTGGTAGTCCACGCCGTAAACGATGAATGTTAGCCGTCGGGCGGTTTACTGCTCGGTGGCGCAGCTA
Th_Bhens  : AGGATTAGATACCCTGGTAGTCCACGCCGTAAACGATGAATGTTAGCCGTCGGGCGGTTTACTGCTCGGTGGCGCAGCTA

                    *       820        *       840        *       860        *       880
BhsM40SHD : ACGCGTTAAACATTCCGCCTGGGGAGTACGGTCGCAAGATTAAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTG
Th_Bhens  : ACGCGTTAAACATTCCGCCTGGGGAGTACGGTCGCAAGATTAAAACTCAAAGGAATTGACGGGGGCCCGCACAAGCGGTG

                    *       900        *       920        *       940        *       960
BhsM40SHD : GAGCATGTGGTTTAATTCGAAGCAACGCGCAGAACCTTACCAGCCCTTGACATCCCGATCGCGGAAGGTGGAGACACCCT
Th_Bhens  : GAGCATGTGGTTTAATTCGAAGCAACGCGCAGAACCTTACCAGCCCTTGACATCCCGATCGCGGAAGGTGGAGACACCCT

                    *       980        *      1000        *      1020        *      1040
BhsM40SHD : CCTTCAGTTAGGCTGGATCGGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGC
Th_Bhens  : CCTTCAGTTAGGCTGGATCGGAGACAGGTGCTGCATGGCTGTCGTCAGCTCGTGTCGTGAGATGTTGGGTTAAGTCCCGC

                    *      1060        *      1080        *      1100        *      1120
BhsM40SHD : AACGAGCGCAACCCTCGCCCTTAGTTGCCAGCATTTGGTTGGGCACTCTAGGGGGACTGCCGGTGATAAGCCGAGAGGAA
Th_Bhens  : AACGAGCGCAACCCTCGCCCTTAGTTGCCAGCATTTGGTTGGGCACTCTAGGGGGACTGCCGGTGATAAGCCGAGAGGAA

                    *      1140        *      1160        *      1180        *      1200
BhsM40SHD : GGTGGGGATGACGTCAAGTCCTCATGGCCCTTACGGGCTGGGCTACACACGTGCTACAATGGTGGTGACAGTGGGCAGCG
Th_Bhens  : GGTGGGGATGACGTCAAGTCCTCATGGCCCTTACGGGCTGGGCTACACACGTGCTACAATGGTGGTGACAGTGGGCAGCG

                    *      1220        *      1240        *      1260        *      1280
BhsM40SHD : AGACCGCGAGGTCGAGCTAATCTCCAAAAGCCATCTCAGTTCGGATTGCACTCTGCAACTCGAGTGCATGAAGTCGGAAT
Th_Bhens  : AGACCGCGAGGTCGAGCTAATCTCCAAAAGCCATCTCAGTTCGGATTGCACTCTGCAACTCGAGTGCATGAAGTCGGAAT

                    *      1300        *      1320        *      1340        *      1360
BhsM40SHD : CGCTAGTAATCGTGGATCAGCATGCCACGGTGAATACGTTCCCGGGCCTTGTACACACCGCCCGTCACACCATGGGAGTT
Th_Bhens  : CGCTAGTAATCGTGGATCAGCATGCCACGGTGA-------------------------------------------------

                    *      1380        *      1400        *      1420        *      1440
BhsM40SHD : GGTTTTACCCGAAGGTGCTGTGCTAACCGCAAGGGGGCAGGCAACCACGGTAGGGTCAGCGACTGGGGTGAAGTCGTAAC
Th_Bhens  : --------------------------------------------------------------------------------

                    *      1460        *      1480
BhsM40SHD : AAGGTAGCCGTAGGGGAACCTGTGGCTGGATCACCTCCTT
Th_Bhens  : ----------------------------------------
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Fig 4–Alignment of 16S rRNA genes: the 16S rRNA gene segment from the Thai clinical isolate has been amplified by PCR, and the obtained DNA sequence was identical (100%) to the 16S rRNA gene sequence for *Bartonella henselae* strain M40SHD, GenBank accession number DQ645426. The universal primer annealing sites are underlined.

another in an epitheloid pattern. Its bacterial origin was finally confirmed and the name bacillary angiomatosis was proposed, originally a transitional term pending proper identification of the causative agents (LeBoit *et al*, 1989; LeBoit, 1990). In the early 1990s, several unusual clinical entities, particularly BA, were described in patients with HIV infection (Winn *et al*, 2006). BA is caused by at least 2 *Bartonella* species, *B. henselae* and *B. quintana* (formerly *Rochalimaea quintana*). The infection results from exposure to flea-infested cats for *B. henselae* and the human body louse for *B. quintana*. BA may be life threatening without therapy. It may involve either the skin, visceral organs, or both, and may be accompanied by systemic symptoms. Besides BA, *B. henselae* infection may present with prolonged fever alone, culture-negative endocarditis (De La Rosa *et al*, 2001) or cat-scratch disease for which the causative agent is not found; the patients respond to macrolide antibiotic which is widely used empirically in Thailand.

This report describes a rare case of BA caused by *B. henselae* in an HIV-infected patient. In Thailand, a case of BA and *Mycobacterium* infection coexisting in a cutaneous lesion in a patient with AIDS was reported (Chiewchanwit *et al*, 1996). However, the diagnosis was based on Warthin-Starry silver stain on sectioned biopsy and no culture was obtained. No case of BA with bacterial culture confirmation has been reported in Thailand.

The reservoir of *B. henselae* is usually the domestic cat. From a report in northern California, USA, 39.5% of 205 cats had *B. henselae* bacteremia; 52% of these bacteremic cats had more than 1,000 colony forming units/ml of blood cultured. Among these animals, 81% tested positive for *B. henselae* antibodies, with bacteremic cats having higher antibody titers than nonbacteremic cats (Chomel *et al*, 1995). In France, blood cultures 53% of 94 stray cats were positive for bacteremia with *Bartonella*

species (Heller *et al*, 1997). In the Netherlands, 50% of 113 cats were seropositive for *Bartonella* species; 22% of the cats also had positive blood cultures (Bergmans *et al*, 1997). Seven of 27 DNA samples extracted from cat fleas removed from these cats contained *Bartonella* DNA. In the USA, *B. henselae* DNA was found in 34% of 132 fleas removed from 47 cats, 89% of whom were bacteremic with *B. henselae* (Chomel *et al*, 1996). The patient in this case walked across the Thai-Myanmar border and stayed in the jungle for some nights. It is possible that transmission of *B. henselae* occurred by insect bite from insects infected with this organism in the environment.

The seroprevalence of *B. henselae* in Thai immunocompetent persons had been reported as 5.5% (Maruyama *et al*, 2000). One study showed that *B. henselae* could be isolated from domestic cats in every region in Thailand (Maruyama *et al*, 2001); hence, we believe that *B. henselae* infections in Thailand are under reported.

BA occurs most frequently in the later stages of HIV infection. In one study of 42 patients, the median CD4 cell count was 21 cells/mm^3 (range: 1-228) at the time of diagnosis of BA (Mohle-Boetani *et al*, 1996). Our patient also had advanced HIV infection.

An antibiotic trial treating cats experimentally infected with *B. henselae* found a statistically significant decrease in levels of bacteremia after treatment with tetracycline or erythromycin (Regnery *et al*, 1996). The clinical response to doxycycline in this case also supported the role of *B. henselae* as the pathogen.

B. henselae is a slow growing bacteria and routine bacterial culture protocols rarely allow this organism to be detected. Making a correct laboratory diagnosis from blood culture in this case was difficult because its slow growth may not achieve established thresholds for detection in an automated blood culture system. There is a suggestion that

periodic subculture and acridine orange staining of blood culture media from an automated blood culture should be done (Spach *et al*, 1995). For other clinical specimens, such as skin biopsy or bone marrow, we usually keep the primary plate cultures (the first media plates, such as blood agar, chocolate agar and MacConkey agar in which a specimen is inoculated on the day it arrives at the clinical microbiology laboratory) in the appropriate incubators (ambient, 5% carbon dioxide or anaerobic incubator) up to 4 days before we discard the plates after observing no growth. We incubate the primary plate culture longer if a physician notifies the laboratory personnel of a suspected organism or writes the clinical diagnosis on a laboratory request form. During prolonged incubation at 35°C, the primary plate culture must be wrapped in a plastic bag or kept in a tight container to prevent drying of culture medium.

Regarding *B. henselae* identification, several methods are available, including phenotypic methods (cellular morphology on Gram stain, colonial morphology and biochemical tests), chemotaxonomic methods using fatty acid analysis in bacterial cells, and molecular techniques (*eg*, polymerase chain reaction, 16S rDNA sequencing). Definitive identification is best accomplished by molecular techniques (Winn *et al*, 2006).

In summary, we recommend that clinicians should be aware of possible infection with this organism in patients with compatible syndromes. A special culture technique should be requested, which with molecular techniques, will help identify patients with *Bartonella* infection.

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REFERENCES

Berbari EF, Cockerill FR, Steckelberg JM. Infective endocarditis due to unusual or fastidious microorganisms. *Mayo Clin Proc* 1997; 72: 532-42.

Bergmans AMC, DeJong CMA, Van Amerongen G, Schot CS, Schouls LM. Prevalence of *Bartonella* species in domestic cats in the Netherlands. *J Clin Microbiol* 1997; 35: 2256-61.

Breitschweerdt EB, Kordick D. *Bartonella* infection in animals: carriership, reservoir potential, pathogenicity, and zoonotic potential for human infection. *Clin Microbiol Rev* 2000; 13: 428-38.

Chiewchanvit S, Chaiwun B. Bacillary angiomatosis and *Mycobacterium* infection coexisting in a cutaneous lesion in a patient with AIDS. *J Med Assoc Thai* 1996; 79: 337-9.

Chomel BB, Abbott RC, Kasten RW, *et al. Bartonella henselae* prevalence in domestic cats in California: risk factors and association between bacteremia and antibody titers. *J Clin Microbiol* 1995; 33: 2445-50.

Chomel BB, Kasten RW, Floyd-Hawkins K, *et al.* Experimental transmission of *Bartonella henselae* by the cat flea. *J Clin Microbiol* 1996; 34: 1952-6.

Cockerell CJ, Whitlow MA, Webster GF, Friedman-Kien AE. Epitheloid angiomatosis: a distinct vascular disorder in patients with the acquired immunodeficiency syndrome or AIDS-related complex. *Lancet* 1987; 2: 654-6.

De La Rosa GR, Barnett BJ, Ericsson CD, Turk JB. Native valve endocarditis due to *Bartonella henselae* in a middle-aged human immunodeficiency virus-negative woman. *J Clin Microbiol* 2001; 39: 3417-9.

Eden PA, Schmidt TM, Blackemore RP, Pace NR.

Phylogenetic analysis of *Aquaspirillum magnetotacticum* using polymerase chain reaction-amplified 16S rRNA-specific DNA. *Int J Syst Bacteriol* 1991; 41: 324-5.

Edwards U, Rogall T, Blocker H, Ende M, Bottger EC. Isolation and direct complete nucleotide determination of entire genes. Characterization of a gene coding for 16S ribosomal RNA. *Nucleic Acids Res* 1989; 17: 7843-53.

Finkelstein JL, Brown TP, O'Reilly KL, Wedincamp J Jr, Foil LD. Studies on the growth of *Bartonella henselae* in the cat flea (Siphonaptera: *Pulicidae*). *J Med Entomol* 2002; 39: 915-9.

Heller R, Artois M, Xemar V, *et al.* Prevalence of *Bartonella henselae* and *Bartonella clarridgeiae* in stray cats. *J Clin Microbiol* 1997; 35: 1327-31.

Kolbert CP, Rys PN, Hopkins M, *et al.* 16 S ribosomal DNA sequence analysis for identification of bacteria in a clinical microbiology laboratory. In: Persing DH, Tenover FC, Vesalovic J, *et al.* eds. Molecular microbiology : diagnostic principles and practice. Washington DC: ASM Press, 2004: 361-90.

LeBoit PE, Berger TG, Egbert BM, Beckstead JH, Yen TS, Stoler MH. Bacillary angiomatosis: the histopathology and differential diagnosis of a pseudoneoplastic infection in patients with human immunodeficiency virus disease. *Am J Pathol* 1989; 13: 909-20.

LeBoit PE. The expanding spectrum of a new disease, bacillary angiomatosis. *Arch Dermatol* 1990; 126: 808-11.

Maruyama S, Boonmar S, Morita Y, *et al.* Seroprevalence of *Bartonella henselae* and *Toxoplasma gondii* among healthy individuals in Thailand. *J Vet Med Sci* 2000; 62: 635-7.

Maruyama S, Sakai T, Morita Y, *et al.* Prevalence of *Bartonella* species and 16s rRNA gene types of *Bartonella henselae* from domestic cats in Thailand. *Am J Trop Med Hyg* 2001; 65: 783-7.

Mohle-Boetani JC, Koehler JE, Berger TG, *et al.* Bacillary angiomatosis and bacillary peliosis in patients infected with human immunodefi-

ciency virus: Clinical characteristics in a case-control study. *Clin Infect Dis* 1996; 22: 794-800.

Parola P, Sanogo OY, Lerdthusnee K, *et al.* Identification of *Rickettsia* spp. and *Bartonella* spp. in fleas from the Thai-Myanmar border. *Ann NY Acad Sci* 2003; 990: 173-81.

Regnery RL, Rooney JA, Johnson AM, *et al.* Experimentally induced *Bartonella henselae* infections followed by challenge exposure and antimicrobial therapy in cats. *Am J Vet Res* 1996; 57: 1714-9.

Slater LN, David FW. *Bartonella*, including cat-scratch disease. In: Mandell GL, Bennett JE, Dolin R, eds. Principals and practice of infectious diseases. 6th ed. Philadelphia: Churchill Livingstone, 2005: 2284-7.

Spach DH, Kanter AS, Daniels NA, *et al. Bartonella* (*Rochalimaea*) *henselae* species as a cause of apparent "culture-negative" endocarditis. *Clin Infect Dis* 1995; 20: 1044-7.

Stoler MH, Bonfiglio TA, Steigbigel RT, Pereira M. An atypical subcutaneous infection associated with acquired immune deficiency syndrome. *Am J Clin Pathol* 1983; 80: 714-8.

Thomson RB Jr, Miller JM. Specimen collection, transport, and processing: Bacteriology. In : Murray PR, Baron EJ, Jorgensen JH, Pfaller MA, Yolken RH, eds. Manual of clinical microbiology. 8th ed. Washington, DC: ASM Press, 2003: 286-330.

Weisburg WG, Barns SM, Pelletier DA, Lane DJ. 16S ribosomal DNA amplification for phylogenetic study. *J Bacteriol* 1991; 173; 697-703.

Welch DF, Slater LN. *Bartonella* and *Alipia*. In: Murray PR, Baron EJ, Jorgensen JH, Pfaller MA, Yolken RH, eds. Manual of clinical microbiology. 8th ed. Washington, DC: ASM Press, 2003: 824-34.

Winn W, Allen S, Janda W, Koneman E, Procop G, Schreckenberger P. Miscellaneous gram-negative bacilli. Chapter 9. In: Koneman's color atlas and textbook of diagnostic microbiology. 6th ed. Baltimore, Maryland: Lippincott Williams & Wilkins, 2006: 497-509.