Human Case of *Ehrlichia chaffeensis* Infection, Taiwan

Shih-Huan Peng, Su-Lin Yang, Yu-Ni Ho, Hsiang-Fei Chen, Pei-Yun Shu

Author affiliations: Centers for Disease Control, Taipei, Taiwan (S.-H. Peng, S.-L. Yang, H.-F. Chen, P.-Y. Shu); Chang Gung Memorial Hospital–Kaohsiung Medical Center, Kaohsiung, Taiwan (Y.-N. Ho)

DOI: https://doi.org/10.3201/eid2511.190665

In 2018, an immunosuppressed woman in southern Taiwan had onset of fever, chills, myalgia, malaise, thrombocytopenia, lymphocytopenia, and elevated hepatic transaminases. Investigation revealed infection with *Ehrlichia chaffeensis*. This autochthonous case of human monocytotropic ehrlichiosis was confirmed by PCR, DNA sequencing, and seroconversion.

Human monocytic ehrlichiosis (HME) is an acute, febrile, tickborne disease caused by the bacterium *Ehrlichia chaffeensis*. HME was first reported in the United States in 1986 (*1*), and >1,000 ehrlichiosis cases have been reported annually since 2012 (https://www.cdc.gov/ehrlichiosis/stats/index.html). In Asia, however, only a limited number of HME cases have been reported in 3 countries (Thailand, South Korea, and China) (*2*–*4*).

Clinical manifestations of HME range from mild febrile illness to severe multiple organ failure. The most common symptoms of HME are fever, headache, myalgia, malaise, nausea, vomiting, diarrhea, and abdominal pain (*5*–*7*), which are difficult to differentiate from the symptoms of other febrile infectious diseases. Therefore, HME must be confirmed by laboratory diagnosis.

Although HME has not been documented in Taiwan, serologic evidence of *Ehrlichia* spp. has been detected in small mammals, such as *Rattus norvegicus*, *R. losea*, and *Bandicota indica* rats that are found around international and local harbors (*8*). In addition, *Haemaphysalis flava* ticks infected with *Ehrlichia* spp. have been collected from pale thrush birds (*Turdus pallidus*) and identified in Taiwan (*9*). We report an autochthonous human case of *E. chaffeensis* infection in Taiwan.

In mid-July 2018, a 66-year-old woman living in the Namaxia District of Kaohsiung City in southern Taiwan was admitted to Kaohsiung Chang Gung Memorial Hospital with a 5-day history of intermittent fever (39.8°C), chills, myalgias, malaise, mild dyspnea, and diffuse abdominal pain. The patient had underlying hypertension, type 2 diabetes mellitus, alcoholic fatty liver, and gastroesophageal reflux disease. Laboratory examinations at admission showed that the patient had thrombocytopenia; lymphocytopenia; elevated levels of C-reactive protein, aspartate aminotransferase, alanine aminotransferase, and creatinine; and an increased number of polymorphonuclear leukocytes (Table). Whole blood counts were within reference ranges, and no leukocytopenia was observed. A chest radiograph showed mild infiltration over the bilateral lower lung fields. Laboratory tests for dengue, influenza A and B, hepatitis A, hepatitis B, and hepatitis C viruses were all

Table. Laboratory and diagnostic findings for a human case of *Ehrlichia chaffeensis* infection, Taiwan*

Laboratory or diagnostic finding	Patient value or result	Reference value or method
Leukocytes	5,800/μL	3.9–10.6 × 10^3/μL
Red blood cell	4,950,000/μL	3.9–5.4 × 10^6/μL
Hemoglobin	14.3 g/dL	12–16 g/dL
Platelets	27,000/μL	150–400 × 10^3/μL
Segment	82.7%	42%–74%
Lymphocyte	13%	25%–56%
Creatinine	1.16 mg/dL	0.44–1.03 mg/dL
Aspartate aminotransferase	97 U/L	0–37 U/L
Alanine aminotransferase	71 U/L	0–40 U/L
C-reactive protein	131.2 mg/L	<5 mg/L
Dengue virus	Negative	Rapid test, ELISA, PCR
Influenza virus	Negative	Antigen
HAV/HBV/HCV	Negative	HAV IgM (ECLIA), HBV HBsAg (ECLIA), HCV Anti-HCV (ECLIA)
Leptospira interrogans	Negative	MAT or isolation
Coxiella burnetii	Negative	PCR or IFA
Orientia tsutsugamushi	Negative	PCR or IFA
Rickettsia typhi/R. prowazekii	Negative	PCR or IFA
R. rickettsii	Negative	IFA
R. conorii	Negative	IFA
Anaplasma phagocytophilum	Negative	PCR or IFA
Ehrlichia chaffeensis	Positive	PCR or IFA

*Diagnostic methods based on guidelines on standard operating procedure for laboratory diagnosis provided by Taiwan Centers for Disease Control (https://www.cdc.gov.tw). ECLIA: electrochemiluminescence immunoassay; HAV, hepatitis A virus, HBsAG, hepatitis B surface antigen; HBV, hepatitis B virus, HCV, hepatitis C virus; IFA, immunofluorescence assay; MAT, microscopic agglutination test.

negative. She was admitted under the impression of atypical infection and thrombocytopenia.

The patient is a coffee farmer who lives in a rural region in Kaohsiung. Although she claimed not to have received arthropod or animal bites, small mammals and birds had often been seen around her workplace and house. Therefore, arthropodborne rickettsial diseases were suspected, and oral doxycycline (100 mg every 12 h) for 4 days and intravenous ceftriaxone (1 g every 12 h) for 7 days were prescribed as empirical therapy on the patient's first day at the hospital. Because ehrlichial infection had not been confirmed during hospitalization, the patient was discharged with a prescription (500 mg cefadroxil monohydrate every 12 h) to be taken for 5 days because of suspicion of atypical bacterial infection.

Blood specimens collected from the patient on day 6 (acute-phase specimens) and day 20 (convalescent-phase specimens) after illness onset were sent to the Taiwan Centers for Disease Control (Taipei, Taiwan) for laboratory diagnosis of zoonotic diseases. DNA extracted from acute-phase blood specimens using the QIAamp DNA blood Mini Kit (QIAGEN GmbH, https://www.qiagen.com) was used to detect *Ehrlichia chaffeensis* infection using a primer set targeting ehrlichial 16S rRNA gene (forward primer: AGCGGCTATCTGGTTCGA; reverse primer: CATGCTCCACCGCTTGTG) and an *E. chaffeensis*–specific primer set targeting the nitrogen assimilation regulatory protein (*ntrX*) gene (forward primer: TGCCGGTAGATATAGTATCGA; reverse primer: ATTTGCGATGAAGTGCGG) by QuantiNova SYBR green real-time PCR (QIAGEN). The PCR products of 16S rRNA (182 bp; GenBank accession no. MN088851) and the *ntrX* gene sequence (153 bp; GenBank accession no. MN096569) were determined and analyzed. The sequence was 100% homologous with the sequences of *E. chaffeensis* strains, including the Arkansas, Jax, Saint Vincent, West Paces, Wakulla, Osceola, Liberty, and Heartland strains. The PCR results were negative for *Coxiella burnetii*, *Orientia tsutsugamushi*, typhus group rickettsiae, spotted fever group rickettsiae, and *Anaplasma phagocytophilum* (Appendix Table, https://wwwnc.cdc.gov/EID/article/25/11/19-0665-App1.pdf). Paired (acute- and convalescent-phase) serum samples were used to detect antibodies against *E. chaffeensis* by using indirect immunofluorescence assay according to the manufacturer's recommendation (Focus Diagnostics, https://www.focusdx.com). IgG against *E. chaffeensis* showed seroconversion (titers ranging from <1:16 to 1:256) of the paired serum samples. IgG against *Coxiella burnetii, Orientia tsutsugamushi*, typhus group rickettsiae, spotted fever group rickettsiae, and *Anaplasma phagocytophilum* were all negative. The results of the microscopic agglutination test and the isolation of *Leptospira* spp. were also negative.

The presence of an HME case highlights the need for further studies of the prevalence, geographic distribution, and control of this disease in Taiwan. Human monocytic ehrlichiosis patients with immunosuppressive conditions, such as diabetes, might have a higher risk for hospitalization and life-threatening complications (*10*). In this case, the suspicion of rickettsial infection was based on the patient's potential exposure to arthropodborne pathogens at her workplace and home, and the patient responded quickly to doxycycline treatment. Physician awareness of HME and early diagnosis and treatment are essential to improve disease outcomes.

This work was supported in part by grant nos. MOHW107-CDC-C-315-112303 and MOHW107-CDC-C-315-123110 from the Centers for Disease Control, Ministry of Health and Welfare, Taiwan, Republic of China.

About the Author

Dr. Peng is a postdoctoral research fellow at the Center for Diagnostics and Vaccine Development at the Taiwan Centers for Disease Control. His research interests include the epidemiology of rickettsial diseases and development of molecular detection methods for vectorborne infectious diseases.

References

1. Dawson JE, Anderson BE, Fishbein DB, Sanchez JL, Goldsmith CS, Wilson KH, et al. Isolation and characterization of an *Ehrlichia* sp. from a patient diagnosed with human ehrlichiosis. J Clin Microbiol. 1991;29:2741–5.
2. Heppner DG, Wongsrichanalai C, Walsh DS, McDaniel P, Eamsila C, Hanson B, et al. Human ehrlichiosis in Thailand. Lancet. 1997;350:785–6. https://doi.org/10.1016/S0140-6736(05)62571-8
3. Heo EJ, Park JH, Koo JR, Park MS, Park MY, Dumler JS, et al. Serologic and molecular detection of *Ehrlichia chaffeensis* and *Anaplasma phagocytophila* (human granulocytic ehrlichiosis agent) in Korean patients. J Clin Microbiol. 2002;40:3082–5. https://doi.org/10.1128/JCM.40.8.3082-3085.2002
4. Zhang L, Shan A, Mathew B, Yin J, Fu X, Zhang J, et al. Rickettsial seroepidemiology among farm workers, Tianjin, People's Republic of China. Emerg Infect Dis. 2008;14:938–40. https://doi.org/10.3201/eid1406.071502
5. Paddock CD, Childs JE. *Ehrlichia chaffeensis*: a prototypical emerging pathogen. Clin Microbiol Rev. 2003;16:37–64. https://doi.org/10.1128/CMR.16.1.37-64.2003
6. Stone JH, Dierberg K, Aram G, Dumler JS. Human monocytic ehrlichiosis. JAMA. 2004;292:2263–70. https://doi.org/10.1001/jama.292.18.2263
7. Biggs HM, Behravesh CB, Bradley KK, Dahlgren FS, Drexler NA, Dumler JS, et al. Diagnosis and management of tickborne rickettsial diseases: Rocky Mountain spotted fever and other spotted fever group rickettsioses, ehrlichioses, and anaplasmosis—United States. MMWR Recomm Rep. 2016;65:1–44. https://doi.org/10.15585/mmwr.rr6502a1
8. Tsai KH, Chang SF, Yen TY, Shih WL, Chen WJ, Wang HC, et al. Prevalence of antibodies against *Ehrlichia* spp. and *Orientia tsutsugamushi* in small mammals around harbors in Taiwan. Parasit Vectors. 2016;9:45. https://doi.org/10.1186/s13071-016-1318-7

9. Kuo CC, Lin YF, Yao CT, Shih HC, Chung LH, Liao HC, et al. Tick-borne pathogens in ticks collected from birds in Taiwan. Parasit Vectors. 2017;10:587. https://doi.org/10.1186/s13071-017-2535-4
10. Nichols Heitman K, Dahlgren FS, Drexler NA, Massung RF, Behravesh CB. Increasing incidence of ehrlichiosis in the United States: a summary of national surveillance of *Ehrlichia chaffeensis* and *Ehrlichia ewingii* infections in the United States, 2008–2012. Am J Trop Med Hyg. 2016;94:52–60. https://doi.org/10.4269/ajtmh.15-0540

Address for correspondence: Pei-Yun Shu, Vector-Borne Viral and Rickettsial Diseases Laboratory, Center for Diagnostics and Vaccine Development, Centers for Disease Control, Ministry of Health and Welfare, No. 161, Kunyang St, Taipei 11561, Taiwan; email:pyshu@cdc.gov.tw

Psittacosis Outbreak among Workers at Chicken Slaughter Plants, Virginia and Georgia, USA, 2018

Kelly A. Shaw,[1] Christine M. Szablewski,[1] Stephanie Kellner, Laura Kornegay, Patricia Bair, Skyler Brennan, Audrey Kunkes, Meredith Davis, Olivia L. McGovern, Jonas Winchell, Miwako Kobayashi, Nancy Burton, Marie A. de Perio, Julie Gabel, Cherie Drenzek, Julia Murphy, Caroline Holsinger, Laurie Forlano

Author affiliations: Centers for Disease Control and Prevention, Atlanta, Georgia, USA (K.A. Shaw, C.M. Szablewski, O.L. McGovern, J. Winchell, M. Kobayashi); Virginia Department of Health, Richmond, Virginia, USA (K.A. Shaw, S. Kellner, L. Kornegay, P. Bair, M. Davis, J. Murphy, C. Holsinger, L. Forlano); Georgia Department of Public Health, Atlanta (C.M. Szablewski, S. Brennan, A. Kunkes, J. Gabel, C. Drenzek); National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA (N. Burton, M.A. de Perio)

DOI: https://doi.org/10.3201/eid2512.190703

During August–October, 2018, an outbreak of severe respiratory illness was reported among poultry slaughter plant workers in Virginia and Georgia, USA. A multiorganizational team investigated the cause and extent of illness, determined that the illness was psittacosis, and evaluated and recommended controls for health hazards in the workplace to prevent additional cases.

[1]These authors contributed equally to this article.

Psittacosis results from inhalation of aerosolized droppings or respiratory secretions of birds infected with *Chlamydia psittaci*. During 2008–2017, a total of 60 cases of psittacosis, a nationally notifiable disease in the United States, were reported to the National Notifiable Diseases Surveillance System (https://wwwn.cdc.gov/nndss).

The most common source of psittacosis in the United States is believed to be pet psittacine birds (e.g., parrots, cockatoos). The most recent large poultry-associated outbreaks in the United States were reported 3 decades ago and were linked to turkeys (*1,2*). *C. psittaci* prevalence in poultry in the United States is unknown, although it has been recently identified in turkeys in the United States (*3*) and turkeys and chickens overseas (*4,5*). Poultry can be infected but show no overt signs of illness (*6*).

During August 31–September 4, 2018, the Virginia Department of Health (VDH) received reports of 10 persons, all workers at the same chicken slaughter plant, hospitalized with fever, headache, cough, and radiographic evidence of pneumonia. Lower respiratory tract specimens (2 bronchoalveolar lavage and 1 sputum) from 3 hospitalized workers were positive for *C. psittaci* by real-time PCR targeting the *C. psittaci* locus tag CPSIT_RS01985 (*7*), performed at the Centers for Disease Control and Prevention (CDC; Atlanta, GA, USA). The Virginia plant suspended operations on September 8.

On September 12, the Georgia Department of Public Health (GDPH) was notified that 3 employees of a Georgia chicken slaughter plant owned by the same company were hospitalized with pneumonia. *C. psittaci* was detected in sputum samples from all 3 patients. The Georgia plant suspended operations on September 15.

After plant closures, VDH and GDPH staff inspected the respective plants, which both slaughter only chickens, and collected environmental samples to test for *C. psittaci*. Staff collected samples from areas where workers were close to or directly handled live chickens or carcasses. Environmental samples were tested for chlamydial species by using real-time PCR, followed by high-resolution melt analysis (*8*), at the University of Georgia Infectious Disease Laboratory (Athens, GA, USA).

The company held employee meetings in each state and invited VDH and GDPH representatives to provide outbreak information and conduct active case finding. VDH and GDPH initiated investigations of cases and potential risk factors. A case was defined as illness in a worker employed during August 1–September 7, 2018, at the

Article DOI: https://doi.org/10.3201/eid2511.190665

Human Case of *Ehrlichia chaffeensis* Infection, Taiwan

Appendix

Appendix Table. Primers used for SYBR green real-time PCR assay in this study

Primer	Target gene (organism)	Sequence (5′ to 3′)	Amplicon (bp)	Reference
DN-F	Capsid(C) (dengue virus)	CAATATGCTGAAACGCGAGAGAAA	171	(*1*)
DN-R		CCCCATCTATTCAGAATCCCTGCT		
EC-F1	16S rRNA (*Ehrlichia* spp.)	AGCGGCTATCTGGTTCGA	218	This study*
EC-R1		CATGCTCCACCGCTTGTG		
EC-F2	ntrX (*Ehrlichia chaffeensis*)	TGCCGGTAGATATAGTATCGA	192	This study*
EC-R2		ATTTGCGATGAAGTGCGG		
Trans1	IS1111 (*Coxiella burnetii*)	TATGTATCCACCGTAGCCAGTC	687	(*2*)
Trans2		CCCAACAACACCTCCTTATTC		
261F	IS1111 (*C. burnetii*)	GAGCGAACCATTGGTATCG	203	(*2*)
463R		CTTTAACAGCGCTTGAACGT		
OTF7	16S rRNA (*Orientia tsutsugamushi*	CCAGYGGGTRATGCCGGGAACTAT	276	(*3*)
OTR6	and *Rickettsia spp.*)	GGCAGTGTGTACAAGGCCCGAGAA		
RST-14F	TSA56 (*O. tsutsugamushi*)	CCATTTGGTGGTACATTAGCTGCAGGT	233	(*4*)
RST-6R		TCACGATCAGCTATACTTATAGGCA		
RT-F	17kDa (*R. typhi*)	GGGTGGTATGAACAAACAAGGGACTG	240	†
RT-R		CGCCATTCTATGTTACTACCGCTAGG		
RP-F	17kDa (*R. prowazekii*)	TGGTCAGAGTGGTATGAACAAACAAG	246	†
RT-R		CGCCATTCTATGTTA CTACCGCTAGG		
SFG-F	17kDa (Spotted fever group)	GGTATGAATAAACAAGGTACAGGAAC	306	†
SFG-R		ATATTGACCAGTGCTATTTCTATAAG		

Primer	Target gene (organism)	Sequence (5′ to 3′)	Amplicon (bp)	Reference
AP-F1	msp2 (*Anaplasma phagocytophilum*)	ACGTTAGCGCTTTGGAGACT	300	†
AP-R1		TCTTGAAGCGCTCGTAACCA		
903f	msp2 (*Anaplasma phagocytophilum*)	AGTTTGACTGGAACACACCTGATC	122	(*5*)
1024r		CTCGTAACCAATCTCAAGCTCAAC		

*The *E. chaffeensis* Arkansas strain was served as positive control for PCR assay. DNA was extracted from acute-phase blood specimens using the QIAamp DNA blood Mini Kit (QIAGEN GmbH, Holden, Germany) according to the manufacturer's instructions. Real-time PCR amplification was performed using QuantiNova SYBR green real-time PCR kit (QIAGEN) with the following parameters: 95°C for 2 minutes (pre-incubation), 40 cycles of 95°C for 5 seconds (denaturation), 60°C for 10 sec (annealing and extension) and melting curve analysis (95°C for 1 minute, lowered to 68°C for 30 seconds and followed by a gradual increase in temperature to 95°C with continuous recording of fluorescence). The results were analyzed with the software program of the LightCycler 96 Real-Time PCR system (Roche Diagnostics, Mannheim Germany).

†Diagnostic methods based on guidelines on standard operating procedure for laboratory diagnosis provided by Taiwan Centers for Disease Control (https://www.cdc.gov.tw).

References

1. Shu PY, Chang SF, Kuo YC, Yueh YY, Chien LJ, Sue CL, et al. Development of group- and serotype-specific one-step SYBR green I-based real-time reverse transcription-PCR assay for dengue virus. J Clin Microbiol. 2003;41:2408–16. PubMed https://doi.org/10.1128/JCM.41.6.2408-2416.2003

2. Parisi A, Fraccalvieri R, Cafiero M, Miccolupo A, Padalino I, Montagna C, et al. Diagnosis of *Coxiella burnetii*-related abortion in Italian domestic ruminants using single-tube nested PCR. Vet Microbiol. 2006;118:101–6. PubMed https://doi.org/10.1016/j.vetmic.2006.06.023

3. Yang SL, Tsai KH, Chen HF, Luo JY, Shu PY. Evaluation of enzyme-linked immunosorbent assay using recombinant 56k-Da type-specific antigens derived from multiple *Orientia tsutsugamushi* strains for detection of scrub typhus infection. Am J Trop Med Hyg. 2019;100:532–9. PubMed https://doi.org/10.4269/ajtmh.18-0391

4. Tsai KH, Lu HY, Tsai JJ, Yu SK, Huang JH, Shu PY. Human case of *Rickettsia felis* infection, Taiwan. Emerg Infect Dis. 2008;14:1970–2. PubMed https://doi.org/10.3201/eid1412.080515

5. Vargas-Hernandez G, André MR, Cendales DM, Sousa KC, Gonçalves LR, Rondelli MC, et al. Molecular detection of *Anaplasma* species in dogs in Colombia. Rev Bras Parasitol Vet. 2016;25:459–64. PubMed https://doi.org/10.1590/s1984-29612016066