

Overview

Useful For

Evaluating patients suspected of acute anaplasmosis or ehrlichiosis

Method Name

Real-Time Polymerase Chain Reaction (PCR)/DNA Probe Hybridization

NY State Available

Yes

Specimen

Specimen Type

Whole Blood EDTA

Specimen Required

Container/Tube: Lavender top (EDTA)

Specimen Volume: 1 mL

Forms

For all ordering locations except for Eau Claire.

[If not ordering electronically, complete, print, and send 1 of the following forms with the specimen:](#)

-[Microbiology Test Request](#) (T244)

-[General Request](#) (T239)

Specimen Minimum Volume

0.3 mL

Reject Due To

Gross hemolysis	OK
Gross lipemia	Reject

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Whole Blood EDTA	Refrigerated (preferred)	7 days	

Clinical & Interpretive

Clinical Information

Ehrlichiosis and anaplasmosis are a group of emerging zoonotic tick-borne infections caused by *Ehrlichia* and *Anaplasma* species, respectively. These obligate intracellular, gram-negative rickettsial organisms infect leukocytes and cause a potentially serious febrile illness in humans.

Human granulocytic anaplasmosis (HA) is caused by *Anaplasma phagocytophilum*, which is transmitted through the bite of an infected *Ixodes* species tick. The epidemiology of this infection in the United States is very much like that of Lyme disease (caused by *Borrelia burgdorferi*) and babesiosis (caused primarily by *Babesia microti*), which all have the same tick vector. HA is most prevalent in the upper Midwest and in other areas of the United States that are endemic for Lyme disease.

Human monocytic ehrlichiosis (HE) is caused by *Ehrlichia chaffeensis*, which is transmitted by the Lone Star tick, *Amblyomma americanum*. Most cases of HE have been reported from the southeastern and south-central regions of the United States. *Ewingii*, the known cause of canine granulocytic ehrlichiosis, can occasionally cause an HE-like illness in humans. Clinical features and laboratory abnormalities are similar to those of *E chaffeensis* infection, and antibodies to *E ewingii* cross-react with current serologic assays for detection of antibodies to *E chaffeensis*.

Most recently, Mayo Clinic Laboratories detected a new species of *Ehrlichia* in patients with exposure to ticks in Wisconsin and Minnesota. This organism is most closely related to *E muris* and has therefore been referred to as the *E muris*-like agent or EMLA. The name *E muris eauclairiensis* has recently been proposed after the city in which the first case was described. *E muris eauclairiensis* causes a similar disease to ehrlichiosis due to *E chaffeensis* and *E ewingii*, and may cause more severe disease in immunocompromised hosts.

Most cases of anaplasmosis and ehrlichiosis are subclinical or mild, but infection can be severe and life-threatening in some individuals. Fever, fatigue, malaise, headache, and other "flu-like" symptoms, including myalgias, arthralgias, and nausea, occur most commonly. Central nervous system involvement can result in seizures and coma.

Diagnosis may be difficult since the patient's clinical course is often mild and nonspecific. This symptom complex is easily confused with other illnesses such as influenza, or other tick-borne zoonoses such as Lyme disease, babesiosis, and Rocky Mountain spotted fever. Clues to the diagnosis of ehrlichiosis in an acutely febrile patient after tick exposure include laboratory findings of leukopenia or thrombocytopenia and elevated serum aminotransferase levels. However, while these abnormal laboratory findings are frequently seen, they are not specific. Rarely, intra-granulocytic or monocytic morulae may be observed on peripheral blood smear, but this is not a reliable means of diagnosing cases of human ehrlichiosis or anaplasmosis.

Definitive diagnosis is usually accomplished through PCR and serologic methods. Serologic testing is done primarily for confirmatory purposes, by demonstrating a 4-fold rise or fall in specific antibody titers to *Ehrlichia* species or *Anaplasma* antigens. There is not currently a commercially available specific serologic test for *E muris eauclairiensis*, but cross-reactivity with the other *Ehrlichia* species by serology may be detected.

PCR techniques allow direct detection of pathogen-specific DNA from patients' whole blood and is the preferred method

for detection during the acute phase of illness. The Mayo PCR assay is capable of detecting and differentiating *A phagocytophilum*, *E chaffeensis*, *E ewingii*, and *E muris eauclairensis*.

It is important to note that concurrent infection with *A phagocytophilum*, *Borrelia burgdorferi*, and *Babesia microti* is not uncommon as these organisms share the same *Ixodes* tick vector, and additional testing for these pathogens may be indicated.

Reference Values

Negative

Interpretation

Positive results indicate presence of specific DNA from *Ehrlichia chaffeensis*, *E ewingii*, *E muris eauclairensis* organism, or *Anaplasma phagocytophilum* and support the diagnosis of ehrlichiosis or anaplasmosis.

Negative results indicate absence of detectable DNA from any of these 4 pathogens in specimens, but do not exclude the presence of these organisms or active or recent disease.

Since DNA of *E ewingii* is indistinguishable from that of *E canis* by this rapid PCR assay, a positive result for *E ewingii/canis* indicates the presence of DNA from either of these 2 organisms.

Cautions

This assay should not be used for screening asymptomatic individuals, and should only be used to test patients with signs and symptoms of ehrlichiosis or anaplasmosis.

A negative result does not indicate absence of disease.

Inadequate specimen draw or improper conditions for storage or transport may invalidate test results.

This test may detect DNA of *Ehrlichia canis* (reported to cause asymptomatic infection in Venezuela only).

This PCR test does not detect DNA of *Rickettsia* (formerly *Ehrlichia*) *sennetsu*, which has been reported to cause a rare mononucleosis-like illness in humans (in Japan and Malaysia).

Supportive Data

The following validation data supports the use of this assay for clinical testing.

Accuracy/Diagnostic Sensitivity and Specificity:

Results from this real-time PCR assay on the LightCycler (LC PCR) were compared to those generated using conventional PCR assay for *Anaplasma phagocytophilum* on 127 unique, archived whole blood specimens (26 positive and 99 negative specimens by conventional PCR). Using the conventional PCR as the gold standard, the diagnostic sensitivity and specificity for detection of *Anaplasma phagocytophilum* were 100%. In addition, 12 known *Ehrlichia chaffeensis* isolates and 2 *Ehrlichia ewingii* isolates (reference strains) were tested by the LC PCR and were positive.

Supplemental Data (Spiking Studies):

To supplement the above data, 30 negative whole blood samples were spiked with *Anaplasma phagocytophilum*

positive control plasmid at the limit of detection (LoD) (10 copies/microlL). The 30 spiked specimens were run in a blinded manner along with 30 negative (nonspiked) specimens. 100% of the spiked specimens were positive, and 100% of the nonspiked specimens were negative.

Analytical Sensitivity/Limit of Detection (LoD):

The lower LoD of this assay for each of the species in EDTA blood is as follows:

- Anaplasma phagocytophilum*=approximately 10 targets per microliter
- Ehrlichia chaffeensis*=approximately 5 targets per microliter
- Ehrlichia muris eauclairensis* =approximately 100 targets per microliter
- Ehrlichia ewingii/canis*=approximately 10 targets per microliter

Analytical Specificity:

No PCR signal was obtained from extracts of the following organisms: herpes simplex virus, Epstein-Barr virus, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bartonella henselae*, *Bartonella quintana*, *Rickettsia typhi*, *Rickettsia rickettsii*, *Toxoplasma gondii*, *Babesia microti* MN, *Babesia microti* ATCC 53899, *Borellia burgdorferi* ATCC 51990, *Ehrlichia risticii* ATCC VR-986, and *Anaplasma marginale*. Positive results were obtained from nucleic extracts of 2 *Ehrlichia canis* strains (patient strain and ATCC CRL-10390 strain), with a melting temperature (T_m) of 49.5 degrees C (indistinguishable from *Ehrlichia ewingii*). A positive melting peak was also noted with *Ehrlichia muris* (ATCC VR-1411), but the T_m (55.24 degrees C) was easily distinguished from the T_m of the target organisms.

Precision:

Interassay precision was 97% and intra-assay precision was 96%.

Reference Range:

Fifty whole blood specimens from normal donors were tested and found to be negative for targeted or detectable *Ehrlichia* and *Anaplasma* species.

Reportable Range:

This is a qualitative assay, and results are reported as either negative or positive for targeted *Ehrlichia/Anaplasma* species (positive for *Anaplasma phagocytophilum*, *Ehrlichia chaffeensis*, *Ehrlichia muris eauclairensis* or *Ehrlichia ewingii*).

Clinical Reference

1. Bakken JS, Dunler JS: Human granulocytic ehrlichiosis. Clin Infect Dis 2000 Aug;31(2):554-560
2. Dunler JS, Bakken JS: Human ehrlichioses: newly recognized infections transmitted by ticks. Ann Rev Med 1998;49:201-213
3. Krause PJ, McKay K, Thompson CA, et al: Disease-specific diagnosis of coinfecting tickborne zoonoses: babesiosis, human granulocytic ehrlichiosis, and Lyme disease. Clin Infect Dis 1999 May 1;34(9):1184-1191
4. McQuiston JH, Paddock CD, Holman RC, Childs JE: The human ehrlichioses in the United States. Emerging Infect Dis 1999 Sept-Oct;5(5):635-642
5. Pritt BS, Sloan LM, Johnson DK, et al: Emergence of a new pathogenic Ehrlichia species, Wisconsin and Minnesota, 2009. N Engl J Med 2011 Aug 4;365(5):422-429
6. Johnson DK, Schiffman E, Davis JP, et al. Human infection with *Ehrlichia muris*-like Pathogen, United States,

2007-2013. Emerging Infect Dis 2015; 21(10):1794-99

Performance

Method Description

Nucleic acid is extracted from the pathogens in blood using the automated MagNA Pure LC system. The extract is then transferred to a 96-well Lightcycler 480 dish for amplification. The LightCycler 480 is an automated instrument that amplifies and monitors the development of target nucleic acid (amplicon) after each cycle of PCR. The DNA target for PCR assay is groEL, the open reading frame gene segment of the heat-shock protein operon (groEL), which is present at a frequency of 1 copy per organism in pathogenic species of *Anaplasma* and *Ehrlichia*. A specific base pair DNA target sequence is amplified by PCR. The detection of amplicon is based on fluorescence resonance energy transfer (FRET), which utilizes a hybridization probe with a donor fluorophore, fluorescein, at the 3' end and a second hybridization probe with an acceptor fluorophore, LC-Red 640, at the 5' end. When the target amplicon is present, the LC-Red 640 emits a measurable and quantifiable light signal at a specific wavelength. Presence of the specific organism nucleic acid may be confirmed by performing a melting curve analysis of the amplicon. Using features of the melting curve analysis, the assay primers and specific hybridization probes are able to detect and differentiate among *Anaplasma phagocytophilum*, *Ehrlichiosis chaffeensis*, *Ehrlichia muris eauclairensis*, and *Ehrlichia ewingii/canis*. Due to close proximity of the melting curves of *Ehrlichia ewingii* and *Ehrlichia canis*, this assay cannot distinguish between these 2 organisms. (Cockerill FR, Uhl FR: Applications and challenges of real-time PCR for the clinical microbiology laboratory. In Rapid Cycle Real-Time PCR. Edited by U Reischl, C Wittwer, F Cockerill. Springer, NY, 2002)

PDF Report

No

Day(s) Performed

Monday through Saturday

Report Available

Same day/1 to 4 days

Specimen Retention Time

1 week

Performing Laboratory Location

Rochester

Fees & Codes

Fees

- Authorized users can sign in to [Test Prices](#) for detailed fee information.
- Clients without access to Test Prices can contact [Customer Service](#) 24 hours a day, seven days a week.

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- Prospective clients should contact their Regional Manager. For assistance, contact [Customer Service](#).

Test Classification

This test was developed, and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. This test has not been cleared or approved by the US Food and Drug Administration.

CPT Code Information

87798 x 4

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
EHRL	Ehrlichia/Anaplasma PCR, B	87548-4

Result ID	Test Result Name	Result LOINC® Value
84319	Anaplasma phagocytophilum	87558-3
23663	Ehrlichia chaffeensis	87559-1
23664	Ehrlichia ewingii/canis	87560-9
32010	Ehrlichia muris eauclairensis	87561-7