Overview

Useful For
Aiding in the distinction between a reactive cytosis and a chronic myeloproliferative disorder
Evaluating for variants in JAK2, CALR, and MPL genes in an algorithmic process

Reflex Tests

<table>
<thead>
<tr>
<th>Test ID</th>
<th>Reporting Name</th>
<th>Available Separately</th>
<th>Always Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALX</td>
<td>CALR, Gene Mutation, Exon 9, Reflex</td>
<td>No, (bill only)</td>
<td>No</td>
</tr>
<tr>
<td>MPLR</td>
<td>MPL Exon 10 Mutation Detection, R</td>
<td>No, (bill only)</td>
<td>No</td>
</tr>
</tbody>
</table>

Testing Algorithm
This reflex test sequentially evaluates for the common major gene variants associated with non-BCR-ABL1-positive myeloproliferative neoplasms until a variant is identified. The testing sequence is based on the reported frequency of gene variants in this disease group. Initial testing evaluates for the presence of the JAK2 V617F variant. If this result is negative or very low positive (0.06%-0.6%), testing proceeds with assessment for CALR gene variants. If the CALR result is also negative, then testing proceeds to evaluate for variants in exon 10 of the MPL gene. If either JAK2 V617F (>0.6%) or CALR variants are detected in the process, the testing algorithm ends; therefore, the complete reflex is followed only in the event of sequential negative variant. An integrated report is issued with the summary of test results.

The following algorithms are available in Special Instructions:

- Myeloproliferative Neoplasm: A Diagnostic Approach to Bone Marrow Evaluation
- Myeloproliferative Neoplasm: A Diagnostic Approach to Peripheral Blood Evaluation

Special Instructions

- Myeloproliferative Neoplasm: A Diagnostic Approach to Peripheral Blood Evaluation
- Myeloproliferative Neoplasm: A Diagnostic Approach to Bone Marrow Evaluation

Method Name
Point Mutation Detection in DNA using Quantitative Polymerase Chain Reaction (PCR)

NY State Available
Yes

Specimen

Specimen Type
Varies
Shipping Instructions
Specimen must arrive within 7 days of collection.

Necessary Information
The following information is required:

1. Pertinent clinical history
2. Clinical or morphologic suspicion
3. Date of collection
4. Specimen source

Specimen Required
Submit only 1 of the following specimens:

Specimen Type: Blood
Container/Tube: Lavender top (EDTA) or yellow top (ACD solution B)
Specimen Volume: 3 mL
Collection Instructions:
1. Invert several times to mix blood.
2. Send specimen in original tube.
3. Label specimen as blood.

Specimen Stability Information: Ambient (preferred)/Refrigerate

Specimen Type: Bone marrow
Container/Tube: Lavender top (EDTA) or yellow top (ACD solution B)
Specimen Volume: 2 mL
Collection Instructions:
1. Invert several times to mix bone marrow.
2. Send specimen in original tube.
3. Label specimen as bone marrow.

Specimen Stability Information: Ambient (preferred)/Refrigerate

Specimen Type: Extracted DNA from blood or bone marrow
Container/Tube: 1.5- to 2-mL tube

Specimen Volume: Entire specimen

Collection Instructions: Label specimen as extracted DNA from blood or bone marrow and provide indication of volume and concentration of the DNA.

Specimen Stability Information: Frozen (preferred)/Refrigerate/Ambient

Forms
If not ordering electronically, complete, print, and send a Hematopathology/Cytogenetics Test Request (T726) with the specimen.

Specimen Minimum Volume
Blood and Bone marrow: 0.5 mL

Reject Due To

<table>
<thead>
<tr>
<th>Gross hemolysis</th>
<th>Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>Paraffin-embedded bone marrow aspirate clot or biopsy blocks Slides Paraffin shavings Moderately to severely clotted</td>
</tr>
</tbody>
</table>

Specimen Stability Information

<table>
<thead>
<tr>
<th>Specimen Type</th>
<th>Temperature</th>
<th>Time</th>
<th>Special Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies</td>
<td>Varies</td>
<td>7 days</td>
<td></td>
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</table>

Clinical and Interpretive

Clinical Information
The Janus kinase 2 gene (JAK2) codes for a tyrosine kinase (JAK2) that is associated with the cytoplasmic portion of a variety of transmembrane cytokine and growth factor receptors important for signal transduction in hematopoietic cells. Signaling via JAK2 activation causes phosphorylation of downstream signal transducers and activators of transcription (STAT) proteins (eg, STAT5) ultimately leading to cell growth and differentiation. BCR-ABL1-negative myeloproliferative neoplasms (MPN) frequently harbor an acquired single nucleotide variant in JAK2 characterized as c.G1849T; p. Val617Phe (V617F). The JAK2 V617F is present in 95% to 98% of polycythemia vera (PV), and 50% to 60% of primary myelofibrosis (PMF) and essential thrombocythemia (ET). It has also been described infrequently in other myeloid neoplasms, including chronic myelomonocytic leukemia and myelodysplastic syndrome.

Detection of the JAK2 V617F is useful to help establish the diagnosis of MPN. However, a negative JAK2 V617F result does not indicate the absence of MPN. Other important molecular markers in BCR-ABL1-negative MPN include CALR exon 9 variant (20%-30% of PMF and ET) and MPL exon 10 variant (5%-10% of PMF and 3%-5% of ET). Variants in JAK2, CALR, and MPL are essentially mutually exclusive. A CALR variant is associated with decreased risk of thrombosis in both ET and PMF, and confers a favorable clinical outcome in PMF patients. A triple negative (JAK2 V617F, CALR, and MPL-negative) genotype is considered a high-risk molecular signature in PMF.

Reference Values
An interpretive report will be provided.
**Interpretation**

The results will be reported as 1 of the 4 following states:

- Positive for *JAK2* V617F variant
- Positive for *CALR* variant
- Positive for *MPL* variant
- Negative for *JAK2* V617F, *CALR*, and *MPL* variants

Positive variant status is highly suggestive of a myeloid neoplasm, but must be correlated with clinical and other laboratory features for definitive diagnosis.

Negative variant status does not exclude the presence of a myeloproliferative neoplasm or other neoplasms.

Results below the laboratory cutoff for positivity are of unclear clinical significance at this time.

**Cautions**

A positive result is not specific for a particular subtype of myeloproliferative neoplasm and clinicopathologic correlation is necessary in all cases.

A negative result does not exclude the presence of a myeloproliferative neoplasm or other neoplastic process.

In rare cases, a variant other than the V617F may be present in an area that interferes with primer or probe binding and cause a false-negative result.

If this test is ordered in the setting of erythrocytosis and suspicion of polycythemia vera, interpretation requires correlation with a concurrent or recent prior bone marrow evaluation.

**Supportive Data**

Analytical sensitivity is determined at 0.06% (by dilution of a *JAK2* V617F-positive cell line into a negative cell line DNA).

**Clinical Reference**


Test Definition: MPNR
MPN (JAK2 V617F, CALR, MPL) Reflex


Performance

Method Description

Genomic DNA is extracted and 2 PCR reactions are used for each sample. In each reaction, a short fragment of genomic DNA, including the variant site, is amplified using quantitative PCR in a real-time PCR instrument. In one reaction, the reverse primer matches the mutated sequence and the PCR conditions are such that it will only bind mutated DNA. In the second reaction, the reverse primer matches the wild-type sequence and the PCR conditions are such that it will only bind the wild-type sequence. In both reactions, the PCR is monitored using TaqMan probe chemistry. The amount of mutated DNA and the amount of wild-type DNA is measured for each sample. In each run, the amount of mutated and wild-type DNA in a calibrator DNA sample is also measured. The calibrator is a mixture of DNA from a positive cell line (HEL) and a negative cell line (HL60) that is frozen in aliquots and expected to give an identical result in each run. Deviations in the calibrator result are assumed to be due to deviations in the run conditions and the sample results are corrected accordingly. Following each reaction, Relative Quantification Software is used to calculate the normalized mutated:wild-type ratio, which is expressed as a unitless ratio following correction with the calibrator data.

The formula for the normalized ratio is as follows:

\[
\text{Normalized ratio} = \frac{\text{mutated/wild-type (sample)}}{\text{mutated/wild-type (calibrator)}}
\]

The final result is reported as % JAK2 V617F of total JAK2 (ie, \([\text{mutated/mutated + wild-type}] \times 100\%\)) calculated from the normalized mutated:wild-type ratio. (Unpublished Mayo method)

PDF Report
No

Day(s) and Time(s) Test Performed
Monday through Friday

Analytic Time
7 days

Maximum Laboratory Time
10 days
Specimen Retention Time
DNA: 3 months

Performing Laboratory Location
Rochester

Fees and 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.
- 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 U.S. Food and Drug Administration.

CPT Code Information
81270-JAK2 (Janus kinase 2) (eg, myeloproliferative disorder) gene analysis, p.Val617Phe (V617F) variant

81219-CALR (calreticulin) (eg, myeloproliferative disorders), gene analysis, common variants in exon 9 (if appropriate)

81403-MPL (myeloproliferative leukemia virus oncogene, thrombopoietin receptor, TPOR) (eg, myeloproliferative disorder), exon 10 sequence (if appropriate)

LOINC® Information

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<tr>
<th>Test ID</th>
<th>Test Order Name</th>
<th>Order LOINC Value</th>
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<tr>
<td>MPNR</td>
<td>MPN (JAK2 V617F, CALR, MPL) Reflex</td>
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<th>Test Result Name</th>
<th>Result LOINC Value</th>
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<td>Final Diagnosis</td>
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