

## Overview

### Useful For

Diagnosis of hemochromatosis using liver tissue specimens

### Testing Algorithm

See [Hereditary Hemochromatosis Algorithm](#) in Special Instructions

### Special Instructions

- [Hereditary Hemochromatosis Algorithm](#)

### Method Name

Inductively Coupled Plasma-Mass Spectrometry (ICP-MS)

### NY State Available

Yes

## Specimen

### Specimen Type

Liver Tissue

### Necessary Information

**Patient's date of birth is required** to calculate iron index.

### Specimen Required

**Supplies:** Metal Free Specimen Vial (T173)

### Container/Tube:

**Preferred:** Mayo metal-free specimen vial (blue label)

**Acceptable:** Paraffin block, if not more than 1 or 2 cuts have been made to it for slides

**Specimen Volume:** 2 mg

### Collection Instructions:

1. **Two mg of liver tissue is required.** This is typically a piece of tissue from a 22-gauge needle biopsy at least 2 cm long. If an 18-gauge needle is used, the tissue must be at least 1 cm in length.

2. Any specimen vial other than a Mayo metal-free vial used should be plastic, leached with 10% nitric acid for 2 days, rinsed with redistilled water, and dried in clean air.

**Additional Information:** Paraffin blocks will be returned 3 days after analysis.

### Reject Due To

All specimens will be evaluated at Mayo Clinic Laboratories for test suitability.

### Specimen Minimum Volume

2 cm (22-gauge needle)

1 cm (18-gauge needle)

2 mm x 2 mm (punch) 0.3 mg by dry weight

### Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Liver Tissue	Refrigerated (preferred)		
	Ambient		
	Frozen		

### Clinical & Interpretive

#### Clinical Information

Hemosiderosis is the condition of excessive iron accumulation in tissues. Liver is the first organ affected in iron-overload diseases. Transient increases in iron first appear in Kupffer cells. This finding is commonly related to sideroblastic anemia, excessive iron consumption, or chronic alcohol ingestion. Persistent hemosiderosis, as seen in hemochromatosis, causes iron accumulation in hepatocytes, and is usually concentrated in biliary cells.

Hereditary hemochromatosis is an autosomal recessive disease with estimated prevalence in the population of 2 in 1,000 in Caucasians, with lower incidence in other races. The gene responsible for hereditary hemochromatosis (*HFE*) is located on chromosome 6; the majority of hereditary hemochromatosis patients have variants in this *HFE* gene. Hereditary hemochromatosis is characterized by an accelerated rate of intestinal iron absorption and progressive iron deposition in various tissues that typically begins to be expressed in the third to fifth decades of life, but may occur in children. The most common presentation is hepatic cirrhosis in combination with hypopituitarism, cardiomyopathy, diabetes, arthritis, or hyperpigmentation. Because of the severe sequelae of this disease if left untreated and recognizing that treatment is relatively simple, early diagnosis before symptoms or signs appear is important.

---

Screening for hemochromatosis is best done by measuring serum iron and transferrin saturation (FEC / Iron and Total Iron-Binding Capacity, Serum). If the serum iron concentration is above 175 mcg/dL and the transferrin saturation is above 55%, analysis of serum ferritin concentration (FERR / Ferritin, Serum) is indicated. A ferritin concentration above 400 ng/mL is suggestive of hemochromatosis, but also can indicate other forms of hepatocyte injury such as alcoholic or viral hepatitis, or other inflammatory disorders involving the liver. *HFE* analysis (*HFE* / Hemochromatosis *HFE* Gene Analysis, Blood) may be used to confirm the clinical diagnosis of hemochromatosis, to diagnose hemochromatosis in asymptomatic individuals with blood tests showing increased iron stores, or for predictive testing of individuals who have a family history of hemochromatosis. The alleles evaluated by *HFE* gene analysis are evident in approximately 80% of patients with hemochromatosis; a negative report for *HFE* gene does not rule-out hemochromatosis. In a patient with negative *HFE* gene testing, elevated iron status for no other obvious reason, and family history of liver disease, additional evaluation of liver iron concentration is indicated.

Diagnosis of hemochromatosis may also be based on biochemical analysis and histologic examination of a liver biopsy. In this assay, results are reported as the hepatic iron index (HII) and dry weight of iron. The HII is considered the "gold standard" for diagnosis of hemochromatosis. This test is appropriate when:

- Serum iron is above 160 mcg/dL
- Transferrin saturation is above 55%
- Ferritin is above 400 ng/mL in males or above 200 ng/mL in females
- HFE* gene test is negative for *HFE* variants

See [Hereditary Hemochromatosis Algorithm](#) in Special Instructions

## Reference Values

### IRON

Males: 200-2,400 mcg/g dry weight

Females: 200-1,800 mcg/g dry weight

### IRON INDEX

Reference values have not been established for patients that are <13 years of age.

<1.0 mcmol/g/year (> or =13 years)

## Interpretation

---

A hepatic iron concentration above 10,000 mcg/g dry weight is diagnostic for hemochromatosis.

Hepatic iron concentrations above 3,000 mcg/g are seen when there is iron overload without cellular injury and cirrhosis. Hepatic iron concentrations greater than the reference range are associated with hemosiderosis, thalassemia, and sideroblastic anemia. Some patients with hepatitis or cirrhosis without significant fibrosis will have hepatic iron concentrations at the top end of normal or just slightly above the normal range.

Iron accumulates in the liver normally with aging. The hepatic iron index (HII) normalizes hepatic iron concentration for age. The HII is calculated from the hepatic iron concentration by converting the concentration from mcg/g to mcmol/g dry weight and dividing by years of age. The normal range for HII is less than 1.0.

-Patients with homozygous hemochromatosis have an HII above 1.9.

-Patients with heterozygous hemochromatosis often have an HII ranging from 1.0 to 1.9.

-Patients with hepatitis and alcoholic cirrhosis usually have an HII below 1.0, although a small percentage of patients with alcoholic cirrhosis have an HII in the range of 1.0 to 1.9.

-Patients with hemochromatosis who have been successfully treated with phlebotomy will have an HII below 1.0.

Liver specimens collected from patients with cirrhosis containing a high degree of fibrosis have results near the low end of the reference range, even though they will show significant iron staining in hepatocytes. While it is true that iron accumulates in hepatocytes in advanced alcoholic cirrhosis with fibrosis, there are relatively few hepatocytes compared to other inert (fibrotic) tissue, so the quantitative iron determination, which is expressed as mcg of iron per gram of dry weight tissues, yields a low result. Histologic examination of all tissue specimens should be performed to facilitate correct interpretation. When structural heterogeneity is apparent histologically, variation in measured iron should be anticipated. We have observed, in approximately 2% of cases, a high degree of hepatic heterogeneity that makes quantitation highly variable.

### **Cautions**

Formalin-fixed, paraffin-embedded tissue can be used when histologic examination (including iron stains) is requested, in addition to the hepatic iron concentration and calculated hepatic iron index. However, fresh or frozen tissue is preferred.

Paraffin blocks from which many slides have been previously cut often appear to contain sufficient quantity of tissue, however, the specimen is often very thin and less than 2 mg in weight.

### **Clinical Reference**

1. Brandhagen DJ, Fairbanks VF, Baldus W: Recognition and management of hereditary hemochromatosis. Am Fam Physician. 2002;65:853-860, 865-866
2. Summers KM, Halliday JW, Powell LW: Identification of homozygous hemochromatosis subjects by measurement of hepatic iron index. Hepatology. 1990;12:20-25
3. Ludwig J, Batts KP, Moyer TP, et al: Liver biopsy diagnosis of homozygous hemochromatosis: a diagnostic algorithm. Mayo Clin Proc. 1993;68:263-267
4. Pietrangelo A: Hemochromatosis: an endocrine liver disease. Hepatology. 2007;46:1291-1301
5. Ashley EA, Butte AJ, Wheeler MT, et al: Clinical assessment incorporating a personal genome. Lancet. 2010;375:1525-1535
6. McLaren CE, Barton JC, Eckfeldt JH, et al: Heritability of serum iron measures in the hemochromatosis and iron overload screening (HEIRS) family study. Am J Hematol. 2010;85:101-105

## Performance

### Method Description

After digestion of the liver tissue with nitric acid and hydrogen peroxide, the digest is diluted and tissue iron concentration is analyzed by inductively coupled plasma-mass spectrometry (ICP-MS) using gallium (Ga) as an internal standard and a aqueous acidic calibration.(Unpublished Mayo method)

### PDF Report

No

### Specimen Retention Time

60 days

### Performing Laboratory Location

Rochester

## Fees & Codes

### 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**

83540

**LOINC® Information**

Test ID	Test Order Name	Order LOINC Value
FET	Iron, Liver Ts	57028-3

Result ID	Reporting Name	LOINC®
8350	Iron, Liver Ts	57028-3
7770	Hepatic Iron Index	49061-5