

# LABORATORY TESTS AND PROCEDURES

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## Introduction

*Chronic hepatitis C* is a complex disease. The course and *symptoms* vary from one person to another.

The liver is one of the most important organs of the body. It performs many jobs including:

- production of *proteins*, *cholesterol*, *bile*, *heme*, and other substances
- regulation of fats in the body
- activation of *vitamins* and drugs
- detoxification of harmful chemicals

With all of these important jobs, many things can potentially go wrong if the liver is damaged. Further complicating the disease is the fact that, although the *hepatitis C virus (HCV)* primarily infects the liver, it can affect any organ system of the body.

Laboratory testing is one tool healthcare providers use to find out how HCV is affecting your body. A number of tests are available. This chapter describes some of the most common laboratory tests used to diagnose and/or monitor chronic hepatitis C.

Your healthcare provider will consider your symptoms and disease status in deciding what tests you need and when they should be done. Therefore, you should not look at this list as tests that should be done, but rather as a list of tests that may be helpful in specific situations.

Other tests are available that are not listed here. If your healthcare provider orders a test you are not familiar with, ask him or her what the test is and why it is being done. If you are considering *interferon-based therapy*, be sure to read, "What You Need to Know Regarding Therapy" in *Chapter 8.2, Initial Treatment Options* for a complete list of recommended tests before, during, and after treatment.

## What Is Normal?

Each testing laboratory has its own range of normal values for each test. A laboratory's normal range means that the majority of people in good health tested by that laboratory have values within this range. Your test results will be compared to the laboratory's normal range. If you have had the same test before, the new result will be compared to previous results. This allows your healthcare provider to look for changes over time. It is important for you and your healthcare provider to know what laboratory is conducting your tests to ensure that appropriate comparisons are being made.

We suggest that you request copies of your laboratory test results for your own files. This can help you better understand and track your disease process.

## Liver Enzymes and Liver Function Tests

You will probably hear your healthcare providers talk about *liver enzymes* and *liver function tests (LFTs)*. These two broad categories of tests give your healthcare providers different information about what is happening in your liver. Liver enzymes

are proteins inside liver cells. When liver cells are damaged, liver enzymes are released into the blood. Therefore, liver enzyme tests indicate how much damage is occurring to your liver. Examples of liver enzymes that are frequently monitored in chronic hepatitis C include *AST*, *ALT*, *GGT*, and *alkaline phosphatase*.

Although liver enzymes indicate how much damage is being done to the liver cells, they do not tell your healthcare provider how much repair is taking place. Unlike many other organs, the liver has a remarkable ability to repair itself. This is important when considering liver enzymes because, although there may be ongoing damage to liver cells, the liver may be able to repair this damage without a decrease in function.

Liver function tests give your healthcare providers information about how well the liver is performing its many jobs. Because the liver has so many different jobs, there are many different liver function tests, each indicating how well the liver is performing a specific job. Examples of LFTs commonly monitored in chronic hepatitis C include *bilirubin*, *albumin*, and *platelet* count.

## Viral Load Testing

HCV *viral load* testing determines how much of the virus is present in the blood. Viral load is one factor your doctor takes into consideration when estimating your chance of success with interferon-based therapy. If you are already on treatment, the test is used to check your response to the medications.

There are different methods used to perform viral load testing including *PCR*, *b-DNA*, and *TMA*. These methods are described later in the chapter. Viral testing methods are often referred to collectively as molecular testing or nucleic acid testing (NAT). Most laboratories buy their testing materials from companies that produce hepatitis C viral testing kits. However, some large laboratories have developed their own testing materials and procedures.

Although it is not necessary for you to understand the technical differences between the various methods of molecular testing, you do need to be aware of the fact that different methods often give different results. Sometimes these differences are quite large. Therefore, when you have HCV viral load testing, you need to be aware of what type of test was used and where the test was performed. Without this information, it is almost impossible to interpret the meaning of changes in viral load.

In addition to the type of viral load test used, you also need to be aware of how the test result is reported. When HCV viral load tests were first developed, the results were reported as the number of copies per mL (copies/mL) or equivalents per mL (equiv/mL). To simplify and standardize reporting, the World Health Organization developed a standard unit for reporting the results of HCV viral load tests. The current reporting standard for viral load testing is International Units per mL (IU/mL).

If your viral loads have been reported in different units over time, you may be confused about what is happening with your viral load. Below are two mathematical conversions to help you.

### If PCR was used

To convert IU/mL into copies/mL, take the result in IU/mL and multiply by 2.7.

Example:  $1,000,000 \text{ IU/mL} \times 2.7 = 2,700,000 \text{ copies/mL}$

To convert copies/mL into IU/mL, take the result in copies/mL and divide by 2.7.

Example:  $2,700,000 \text{ copies/mL} \div 2.7 = 1,000,000 \text{ IU/mL}$

### If TMA was used

To convert IU/mL into copies/mL, take the result in IU/mL and multiply by 5.2.

Example:  $1,000,000 \text{ IU/mL} \times 5.2 = 5,200,000 \text{ copies/mL}$

To convert from copies/mL into IU/mL, take the result in copies/mL and divide by 5.2.

Example:  $5,200,000 \text{ copies/mL} \div 5.2 = 1,000,000 \text{ IU/mL}$

**HCV viral loads do not reflect liver disease status nor disease progression.**

HCV viral loads fluctuate within a very broad range. These fluctuations are typical of untreated, chronic hepatitis C. Therefore, many healthcare providers do not monitor HCV viral load in people who are not on interferon-based therapy. However, if you are considering interferon-based therapy or are on such treatment, your HCV viral load becomes important.

HCV viral load is measured before and during interferon-based therapy because it is used to determine response to treatment. Research has shown that those people who experience a *sustained viral response* to interferon-based therapy have a significant drop in HCV viral load by week 12 of treatment (an early viral response or EVR). More recently, researchers have been studying a new time point in predicting the probability of sustained viral response to interferon-based therapy. This new time point has been dubbed rapid viral response or RVR and describes a significant drop in HCV viral load by week 4 of treatment.

#### **HCV Viral Response Terms**

**EVR: Early Viral Response**

Greater than or equal to 100-fold drop in HCV viral load by week 12 of interferon-based treatment.

**RVR: Rapid Viral Response**

Greater than or equal to 100-fold drop in HCV viral load by week 4 of interferon-based treatment.

**SVR: Sustained Viral Response**

Undetectable hepatitis C virus for at least 24 weeks after therapy is completed.

Healthcare providers often discuss viral load changes using the term “logs.” The term “log” refers to the mathematical notation called logarithms. Although there are many log scales, when used to discuss viral load, the scale being referred to is log<sub>10</sub> or log base 10. While this may seem complicated, the use of logs is just a shorthand way of talking about viral load changes.

**1-log change is a 10-fold change in viral load**

Examples:

1,000 copies/mL to 10,000 copies/mL is a 1-log increase in viral load  
→ (1,000 × 10 = 10,000)

50,000,000 copies/mL to 5,000,000 copies/mL is a 1-log decrease in viral load  
→ (50,000,000 ÷ 10 = 5,000,000)

**2-log change is a 100-fold change in viral load**

Examples:

1,000 copies/mL to 100,000 copies/mL is a 2-log increase in viral load  
→ (1,000 × 100 = 100,000)

8,500,000 copies/mL to 85,000 copies/mL is a 2-log decrease in viral load  
→ (8,500,000 ÷ 100 = 85,000)

**3-log change is a 1,000-fold change in viral load**

Examples:

1,000 copies/mL to 1,000,000 copies/mL is a 3-log increase in viral load

→  $(1,000 \times 1,000 = 1,000,000)$

250,000,000 copies/mL to 250,000 copies/mL is a 3-log decrease in viral load

→  $(250,000,000 \div 1,000 = 250,000)$

If you have questions about a change in your viral load, talk with your healthcare provider. He or she can explain what your test results mean.

## Sample Laboratory Report

Following is a sample laboratory report. The tests on the sample report are described in the next section of this chapter.



**The Testing Laboratory**  
**100 The Road**  
**Anytown, OH 00000**

Patient: John DoeSex: MDoB: 12/01/55

TEST	RESULT	NORMAL RANGE (see note below)
WBC	7.2	5-10 thousand/mm <sup>3</sup>
RBC	4.80	4.70-6.10 million/ mm <sup>3</sup>
Hemoglobin	13.6 L	14.0-18.0 g/dL
Hematocrit	41.6 L	42.0-52.0%
Platelet Count	260	140-440 thousand/ mm <sup>3</sup>
PT	11.9	10.0-12.5 seconds (0.9-1.1 INR)
Fibrinogen	385	150-450 mg/dL
Sodium	141	140-148 mmol/L
Potassium	3.9	3.6-5.2 mmol/L
Chloride	104	100-108 mmol/L
Carbon Dioxide	24.5	21.0-32.0 mmol/L
Albumin	3.4	3.4-5.0 g/dL
Total Protein	6.2 L	6.4-8.2 g/dL
Glucose	85	70-110 mg/dL
Cholesterol, Total	216 H	<200 mg/dL
BUN	10	7-18 mg/dL
Creatinine	0.8	0.6-1.3 mg/dL
Bilirubin, Total	0.18	0.00-1.00 mg/dL
AST	42 H	15-37 IU/L
ALT	78 H	30-65 IU/L
GGT	46	5-85 IU/L
Alk Phos	74	50-136 IU/L
Ethanol	0	None detected
Ammonia	18	11-35 μmol/L
Ferritin	149	15-200 ng/mL
AFP	12	<25 ng/mL
HCV Antibodies	positive*	negative
HCV RNA	650,000*	undetectable
HCV Genotype	1b	-----
ANA	negative	negative
Cryoglobulins	negative	negative

**IMPORTANT NOTE:** This laboratory report is only an example. The units and normal ranges reported by your testing laboratory may be different. Please see your own laboratory reports to find if your test values are within *your* laboratory's normal range.

## Laboratory Test List

The laboratory tests described below are in alphabetical order. For each test, you will see:

- the name of the test
- other names for the test (if applicable)
- what the test is
- why the test is used in people with chronic hepatitis C

Be aware that there are other uses for many of the tests listed, but only their role in hepatitis C is described here.

**AFP** – see *alfa-fetoprotein*

### **alanine aminotransferase (ALT)**

#### **Other Names**

alanine transaminase, previously called *glutamate pyruvate transaminase (GPT or SGPT)*

#### **What?**

*alanine aminotransferase (ALT)* is an enzyme found inside liver cells. It is also found in other cells such as those of the heart and pancreas. The liver contains large amounts of ALT.

#### **Why Test?**

Testing the blood for ALT is one way of telling if liver cells are dying. When liver cells die, ALT is released into the blood. ALT levels rise over a period of 7 to 12 days, and then slowly return to normal. When there is ongoing liver cell death, ALT levels remain elevated. Your ALT level tells your healthcare provider how much ongoing damage is occurring in your liver. However, an elevated ALT level does not necessarily mean your liver disease is getting worse because this test cannot determine how much repair is occurring and how many new liver cells are being produced.

### **albumin**

#### **What?**

Albumin is the most abundant protein in the blood. It is made in the liver.

#### **Why Test?**

In advanced *cirrhosis*, the liver begins to fail at its many jobs. Since albumin is made in the liver, a failing liver may not make enough albumin. Measuring albumin is one way of testing how well a cirrhotic liver is making proteins.

### **alcohol**

#### **What?**

*Alcohol* is the intoxicating substance in beer, wine, and hard liquor. It may also be found in over-the-counter medications such as cough syrups, and in certain mouthwashes and other products.

#### **Why Test?**

Alcohol is toxic to the liver. People with hepatitis C should not consume any alcohol. Research has shown that even small amounts of alcohol may worsen the damage done to your liver by the hepatitis C virus. Your blood alcohol should always be zero.

### **alfa-fetoprotein (AFP)**

#### **What?**

*Alfa-fetoprotein (AFP)* is a substance normally found in only trace amounts in the body. High amounts may indicate the presence of a *tumor*.

#### **Why Test?**

People with chronic hepatitis C are at increased risk for *liver cancer*. Alfa-fetoprotein is a tumor marker for liver cancer, meaning an abnormally high amount may indicate the presence of a cancerous liver tumor. Elevated alfa-fetoprotein does not always indicate the presence of liver cancer. However, it is often used to screen for the disease in people with HCV.

**alkaline phosphatase (ALP or alk phos)****What?**

ALP is an enzyme found in nearly every tissue of the body. The highest concentrations of ALP are found in the liver, bones, intestines, kidneys, and the placentas of pregnant women. In normal adult men and non-pregnant adult women, most of the alkaline phosphatase in the blood comes from the liver and bones.

**Why Test?**

Testing the blood for ALP is one way to know if the bile ducts of the liver are working normally. When liver cells die, scarring takes place. Scarring may cause blockage of the bile ducts slowing bile flow through the liver. This condition is called *cholestasis*. Cholestasis causes the liver to make more ALP. Some of this ALP is released into the blood. ALP is also elevated when bile flow is blocked outside the liver. A common cause of this type of blockage is gallstones.

**alkaline phosphatase isoenzymes (ALP isoenzymes)****What?**

ALP from different tissues differs chemically. The ALP isoenzyme test measures the different forms of ALP.

**Why Test?**

If the ALP is elevated in the blood, it is important to know what tissue(s) it came from. The test for ALP isoenzymes measures how much ALP is from the liver and how much is from other tissues. Elevated ALP from the liver usually indicates a blockage of bile flow either inside or outside the liver.

**ALT** – see *alanine aminotransferase*

**aminopyrine clearance test****What?**

Aminopyrine is a chemical used to determine how well the liver is *metabolizing* and detoxifying substances.

**Why Test?**

Two of the liver's many important jobs are to metabolize drugs and detoxify foreign chemicals. The *aminopyrine clearance test* is used to determine how well the liver is performing these jobs. A single test does not give much useful information, but comparing a series of tests over time can show if liver function is decreasing.

**ammonia****What?**

*Ammonia* is a chemical normally found in very low levels in the blood. It comes from the normal breakdown of proteins in the body.

**Why Test?**

One potential complication of cirrhosis and *portal hypertension* is a condition called *hepatic encephalopathy*. See *Chapter 5, Signs and Symptoms That May be Associated with Hepatitis C* for an explanation of hepatic encephalopathy. Ammonia levels are high in hepatic encephalopathy and testing for ammonia can help make the diagnosis.

**anti-HCV antibodies****Other Names**

*HCV antibodies, hepatitis C screening test, HCV-EIA*

**What?**

After being exposed to the hepatitis C virus, the body develops several different *antibodies* to the virus. The anti-HCV test detects these antibodies.

**Why Test?**

The presence of HCV antibodies indicates a person has been exposed to HCV. Several different tests are available to detect HCV antibodies. Depending on the test used, there are differences in how soon HCV antibodies can be detected in the blood after exposure to the virus. If this screening test is positive, a second test called a confirmatory test is usually performed to test for the hepatitis C virus itself. The presence of the hepatitis C virus in the blood confirms current infection with the virus. The *anti-HCV antibody* test cannot tell whether you currently have the hepatitis C virus in your body. It only determines whether you have been exposed to the virus.

**anti-liver-kidney microsomal antibodies (anti-LKM)**

**What?**

*Anti-liver-kidney microsomal antibodies (anti-LKM)* are a type of *autoantibody*. Normally, the body makes antibodies only against foreign substances such as bacteria and viruses. *Autoantibodies* are abnormal antibodies that act against your own cells.

**Why Test?**

More than half of all people with chronic hepatitis C have one or more autoantibodies in their blood. This is important to know because autoantibodies can cause additional symptoms and disease.

**anti-nuclear antibodies (ANA)**

**What?**

*Anti-nuclear antibodies (ANA)* are a type of autoantibody. Normally, the body makes antibodies only against foreign substances such as bacteria and viruses. Autoantibodies are abnormal antibodies that act against your own cells.

**Why Test?**

More than half of all people with chronic hepatitis C have one or more autoantibodies in their blood. This is important to know because autoantibodies can cause additional symptoms and disease.

**anti-smooth muscle antibodies (anti-SMA)**

**What?**

*Anti-smooth muscle antibodies (anti-SMA)* are a type of autoantibody. Normally, the body makes antibodies only against foreign substances such as bacteria and viruses. Autoantibodies are abnormal antibodies that act against your own cells.

**Why Test?**

More than half of all people with chronic hepatitis C have one or more autoantibodies in their blood. This is important to know because autoantibodies can cause additional symptoms and disease.

**APTT** – see *partial thromboplastin time*

**aspartate aminotransferase (AST)**

**Other Names**

aspartate transaminase, previously called *glutamate oxaloacetate transaminase (GOT or SGOT)*

**What?**

*Aspartate aminotransferase (AST)* is an enzyme found in liver cells. It is also found in other cells such as those of the heart and muscles. The largest amounts of AST are found in the heart and liver.

**Why Test?**

Testing the blood for AST is one way of telling if liver cells are dying. When liver cells die, AST is released into the blood. AST levels rise over a period of 7 to 12 days, and then slowly return to normal. When there is ongoing liver cell death, AST levels remain elevated. Your AST level tells your healthcare provider how much ongoing damage is occurring in your liver. However, an elevated AST level does not necessarily mean your liver disease is getting worse because this test cannot determine how much repair is occurring and how many new liver cells are being produced.

**AST** – see *aspartate aminotransferase*

**AST/ALT Ratio**

**What?**

This is not a laboratory test per se, but rather a calculation based on the AST and ALT test results. The AST result is divided by the ALT result to get the ratio.

**Why Test?**

In patients with viral hepatitis, elevations in ALT are typically equal to or greater than AST elevations. This results in an AST/ALT ratio less than or equal to 1. Conversely, ALT is typically elevated to a lesser degree than AST in alcoholic liver disease and cirrhosis. This results in an AST/ALT greater than 1. Following the AST/ALT ratio over time is one of the many pieces of information doctors use in monitoring for the development of cirrhosis.

**bicarbonate (HCO<sub>3</sub>)****Other Names**

total carbon dioxide

**What?**

*Bicarbonate* is a charged particle called an *electrolyte*. It is one of four major electrolytes in the body.

**Why Test?**

Electrolytes perform many important jobs in the body. Two of the most important jobs are regulating the amount of water in your body and keeping your blood pH normal. Some people with hepatitis C hold more water in their bodies than they need. This can cause abnormal bicarbonate levels. This is more likely in people with cirrhosis than in those without cirrhosis.

**bile acids****What?**

*Bile acids* are a group of chemicals produced by the breakdown of *cholesterol*.

**Why Test?**

Blood bile acid levels are a sensitive indicator of liver and gall bladder function. Abnormal bile acid levels suggest abnormal functioning of the liver and/or gall bladder.

**bilirubin, conjugated****Other Names**

*direct bilirubin*

**What?**

*Bilirubin* is a yellow chemical produced during the normal breakdown of red blood cells. Bilirubin is normally processed by the liver into other substances that can be eliminated from the body. There are two forms of bilirubin in the body, conjugated (direct) bilirubin and unconjugated (indirect) bilirubin. *Conjugated bilirubin* is bilirubin that is attached to another chemical called glucuronic acid in a process called conjugation. Conjugation takes place inside liver cells. Conjugated bilirubin is excreted in the bile. Normally, conjugated bilirubin makes up less than 10% of the total bilirubin.

**Why Test?**

If the total bilirubin in the blood is high, it is important to know how much of it is conjugated because this tells your healthcare provider what process in the liver is not working normally. High amounts of conjugated bilirubin usually means the bile flow is blocked either inside or outside the liver. Problems inside the liver such as hepatitis, *fibrosis*, and cirrhosis can cause increased conjugated bilirubin. Problems outside the liver such as gallstones can also cause increased conjugated bilirubin. A high level of conjugated bilirubin in the blood can also be detected in the urine.

**bilirubin, total****What?**

Bilirubin is a yellow chemical produced during the normal breakdown of red blood cells. Bilirubin is normally processed by the liver into other substances that can be eliminated from the body.

**Why test?**

Testing the blood for bilirubin is one measure of how well the liver is working. When the liver is not working normally, bilirubin can build up in the body. If bilirubin levels get very high, the skin and/or the whites of the eyes will become yellow, a condition called *jaundice*. However, bilirubin levels can be elevated without jaundice.

**bilirubin, unconjugated****Other Names**

*indirect bilirubin*

**What?**

Bilirubin is a yellow chemical produced during the normal breakdown of red blood cells. Bilirubin is normally processed by the liver into other substances that can be eliminated from the body. There are two types of

bilirubin in the body, conjugated (direct) bilirubin and unconjugated (indirect) bilirubin. Conjugated bilirubin is bilirubin that is attached to another chemical called glucuronic acid in a process called conjugation. Conjugation takes place inside liver cells. Conjugated bilirubin is excreted in the bile. *Unconjugated bilirubin* has not undergone the conjugation process. Normally, unconjugated bilirubin makes up over 90% of the total bilirubin.

**Why Test?**

If the total bilirubin in the blood is high, it is important to know how much of it is unconjugated because this tells your healthcare provider what process in the liver is not working normally. In hepatitis, fibrosis, and cirrhosis, high amounts of unconjugated bilirubin signify the liver is not conjugating bilirubin normally causing it to build up in the blood.

**blood urea nitrogen (BUN)**

**What?**

*Blood urea nitrogen (BUN)* is a chemical produced by the liver in the process of breaking down proteins.

**Why Test?**

BUN is normally eliminated from the body in the urine. BUN is most commonly measured to check how well the kidneys are working. When the kidneys are not working normally, BUN increases. Some people with advanced cirrhosis and *liver failure* develop a condition called hepatorenal syndrome. With this syndrome, the kidneys begin to fail because the liver is failing. BUN is one test used to check for hepatorenal syndrome in people with cirrhosis and liver failure.

In the absence of kidney failure, BUN is often lower than normal in people with cirrhosis and liver failure. This is because the failing liver does not metabolize proteins normally, and as a result, lower than normal amounts of BUN are produced. Because of this, BUN is one test that can be used to see how well the liver is performing one of its many jobs in people with cirrhosis and liver failure, but no kidney failure.

**branched DNA test for HCV (b-DNA)**

**What?**

The *branched DNA test* for HCV (b-DNA) is used to check for the presence of the virus in the blood.

**Why Test?**

HCV viral load testing is used to predict possible response to interferon-based therapy, and to monitor for response during such therapy. The b-DNA test is one form of HCV viral load testing. In order for a b-DNA test to be positive, there has to be a certain amount of virus in the blood. For this reason, a negative b-DNA test is reported as “undetectable,” not zero. The b-DNA test for HCV is not as sensitive as the *HCV PCR* test, another test used to check viral load. This means the b-DNA test cannot detect as low a viral load as the HCV PCR test.

See “Viral Load Testing” at the beginning of this chapter for additional information on the use and interpretation of HCV viral load tests.

**BUN** – see *blood urea nitrogen*

**caffeine metabolism**

**What?**

*Caffeine* is the stimulating chemical in coffee, black teas, colas, chocolate, and other foods. Caffeine is processed (metabolized) by the liver.

**Why Test?**

Caffeine *metabolism* decreases as liver function decreases. Therefore, caffeine metabolism is one way to evaluate liver function. The rate of caffeine metabolism is markedly decreased in people with cirrhosis. Caffeine metabolism can be evaluated by checking the fasting caffeine level in the blood, measuring the release of radiolabeled carbon dioxide in the breath after a dose of labeled caffeine is administered, or measuring the rate of elimination of caffeine from the blood after a loading dose is administered.

**calcium**

**What?**

*Calcium* is a charged particle called an electrolyte. It is needed for many important functions of the body including bone formation and muscle activity.

**Why Test?**

People with cirrhosis can have lower than normal *vitamin D* levels because it is not being absorbed normally in the intestines. When the level of vitamin D is too low, the amount of calcium in the blood also drops. Many different symptoms can occur if your calcium is too low. If cirrhosis has led to development of hepatorenal syndrome in which both the kidneys and the liver fail, the blood calcium can become elevated, which can cause other problems.

**CBC** – see *complete blood count*

**chloride (Cl)****What?**

*Chloride (Cl)* is a charged particle called an electrolyte. It is one of the four major electrolytes in the body.

**Why Test?**

Electrolytes perform many important jobs in the body. Two of the most important jobs are regulating the amount of water in your body and keeping your blood pH normal. Some people with hepatitis C hold more water in their bodies than they need. This can cause abnormal chloride levels. This is more likely in people with cirrhosis than in those without cirrhosis.

**cholesterol****What?**

*Cholesterol* is a *lipid* or fat that is both absorbed from the food we eat and manufactured by the liver. Most of the circulating blood cholesterol comes from the liver, not from what we eat.

**Why Test?**

The liver is responsible for both production and breakdown of cholesterol. The liver breaks down cholesterol and excretes it into the bile. Blockage of bile flow either inside or outside the liver increases the amount of cholesterol in the blood. The more obstructed the bile flow, the higher the amount of cholesterol in the blood. Cirrhosis can block bile flow in the liver, and gallstones can block bile flow outside of the liver. Both of these situations can occur with chronic hepatitis C infection.

**complete blood count (CBC)****What?**

A *complete blood count (CBC)* is a group of tests indicating the concentration and characteristics of cells circulating in the blood. A CBC typically includes the following tests: *RBC count*, *WBC count*, *hemoglobin*, *hematocrit*, and *platelet count*. Other tests may also be included.

**Why Test?**

See individual tests for an explanation of the role of each test in chronic hepatitis C.

**conjugated bilirubin** – see *bilirubin, conjugated*

**coproporphyrin****What?**

*Coproporphyrin* is a substance produced in the liver and bone marrow during the process of making a chemical called heme. Heme is the chemical that binds oxygen to red blood cells.

**Why Test?**

Since the liver is one of two sites for heme production, liver cell damage can interfere with the production of heme. When heme production is abnormal, the substances used to make heme build up in the blood. Coproporphyrin is used to determine how well the liver is performing its job of making heme.

**creatinine****What?**

*Creatinine* is a waste product of muscle cell metabolism. Creatinine is excreted by the kidneys in the urine.

**Why Test?**

Creatinine is most commonly measured to check how well the kidneys are working. When the kidneys are not working normally, blood creatinine increases. Some people with advanced liver cirrhosis and liver failure develop

a condition called hepatorenal syndrome. With this syndrome, the kidneys begin to fail because the liver is failing. Creatinine is one test used to check for hepatorenal syndrome in people with cirrhosis and liver failure.

### **cryoglobulins**

#### **What?**

*Cryoglobulins* are *immunoglobulins* that are joined together.

#### **Why Test?**

Some people with hepatitis C develop cryoglobulins in their blood, a condition called *cryoglobulinemia*. It is important to know if someone has cryoglobulinemia because it can cause kidney damage and problems with other organ systems.

**direct bilirubin** – see *bilirubin, conjugated*

### **enzyme immunoassay (EIA)**

#### **What?**

*Enzyme immunoassay (EIA)* is a common testing method used to screen for anti-HCV antibodies in the blood.

#### **Why Test?**

EIA is a rapid, economical method of screening for the presence of anti-HCV antibodies. A *RIBA* test is often used to confirm a positive EIA test for anti-HCV antibodies. For additional information about the significance of a positive test result, see anti-HCV antibodies.

### **ferritin**

#### **What?**

*Ferritin* is a protein found in the liver, spleen, and intestine. It binds *iron*.

#### **Why Test?**

Ferritin is measured to check for iron overload in the body. High amounts of ferritin in the blood signify an overabundance of iron in the body. This is important because iron overload is often seen with chronic hepatitis C. This condition must be treated because iron overload worsens the damage done to the liver by the hepatitis C virus.

### **fibrinogen**

#### **What?**

*Fibrinogen* is a protein produced by the liver. It is the main protein used to form blood clots to stop bleeding.

#### **Why Test?**

A cirrhotic, failing liver may be unable to produce normal amounts of fibrinogen. Measuring fibrinogen is one way of telling how severely the liver is failing. Testing the amount of fibrinogen in the blood is also important because, if the level gets very low, a person may not be able to form a blood clot if he or she begins to bleed for any reason.

### **FIBROSpect™**

#### **What?**

*FIBROSpect™* is a proprietary set of blood tests used together to differentiate no/mild liver fibrosis from severe fibrosis.

#### **Why Test?**

*Liver biopsy* remains the most certain method of determining the presence and degree of liver fibrosis. However, some people are hesitant to have a liver biopsy because it is an invasive test and has an associated risk of rare but serious complications. While *FIBROSpect™* is not a substitute for liver biopsy, it can possibly provide some useful information for people who cannot or do not wish to have a liver biopsy.

### **FibroSURE™**

#### **Other Names**

HCV FibroSURE™

#### **What?**

*FibroSURE™* is a proprietary set of blood tests used together to differentiate no/mild liver fibrosis from severe fibrosis.

**Why Test?**

Liver biopsy remains the most certain method of determining the presence and degree of liver fibrosis. However, some people are hesitant to have a liver biopsy because it is an invasive test and has an associated risk of rare but serious complications. While FibroSURE™ is not a substitute for liver biopsy, it can possibly provide some useful information for people who cannot or do not wish to have a liver biopsy.

**gamma-glutamyl transferase (GGT)****Other Names**

GGTP, glutamyl peptide

**What?**

*Gamma-glutamyl transferase (GGT)* is an enzyme found in all cells of the body except muscle cells.

**Why Test?**

GGT is elevated in all forms of liver disease. It is highest when bile flow is blocked either inside or outside the liver.

**genotyping****What?**

There are many different strains of the hepatitis C virus. A *genotyping* test tells what strain of the virus a person has.

**Why Test?**

Genotyping is currently used to determine the required length and potential response to interferon-based therapy. There are 6 common *HCV genotypes*. Researchers have discovered that certain genotypes are more likely to respond to treatment than others are. Future studies will hopefully uncover why this occurs. This may allow researchers to develop more effective treatments for HCV.

GGT – see *gamma-glutamyl transferase*

GGTP – see *gamma-glutamyl transferase*

**glucose****What?**

*Glucose* is another name for *blood sugar*.

**Why Test?**

People with chronic hepatitis C can have blood sugar abnormalities, either too high or too low. A glucose test is done to see if your blood sugar level is abnormal.

**glutathione****What?**

*Glutathione* is an *amino acid* found throughout the body.

**Why Test?**

Glutathione protects cells from a type of injury called oxidative damage. Scientists believe oxidative damage is one of the key ways HCV damages liver cells. This damage is done by agents called *free radicals*. Glutathione prevents free radicals from causing damage to cells. Measuring the amount of glutathione in the blood is one way your healthcare providers can tell how capable your liver is of preventing and/or repairing liver damage.

**HCV polymerase chain reaction (HCV PCR)****Other Names**

PCR, RT-PCR, reverse transcription polymerase chain reaction

**What?**

HCV PCR checks for the presence of HCV in the blood. The test detects the genetic material of the virus (*HCV RNA*).

**Why Test?**

HCV viral load testing is used to predict possible response to interferon-based therapy, and to monitor for response during such therapy. The PCR test is one form of HCV viral load testing. The HCV PCR test is also used

to confirm the diagnosis of current HCV infection in someone who has tested positive on a hepatitis C antibody screen.

There are two types of HCV PCR tests. The first is a qualitative test. A qualitative HCV PCR test does not measure the amount of virus in the blood, but rather determines if there is detectable virus in the blood. The second type of test is called a quantitative test. It is used to measure the amount of detectable HCV in the blood. The amount of detectable virus is called the viral load.

A certain amount of virus must be present in the blood to be detected using PCR. For this reason, a negative PCR test is reported as “undetectable,” not zero. See “Viral Load Testing” at the beginning of this chapter for additional information on the use and interpretation of HCV viral load tests.

#### **HCV transcription mediation amplification (HCV TMA)**

##### **What?**

*HCV TMA* is used to measure the amount of detectable HCV in the blood.

##### **Why Test?**

HCV viral load testing is used to predict possible response to interferon-based therapy, and to monitor for response during such therapy. The TMA test is one form of HCV viral load testing. The HCV TMA test is also used to confirm the diagnosis of current HCV infection in someone who has tested positive on a hepatitis C *antibody* screen. A certain amount of virus must be present in the blood to be detected using TMA. For this reason, a negative TMA test is reported as “undetectable,” not zero. See “Viral Load Testing” at the beginning of this chapter for additional information on the use and interpretation of HCV viral load tests.

#### **hematocrit (HCT)**

##### **What?**

A *hematocrit (HCT)* test measures the percentage of the blood made up by red blood cells.

##### **Why Test?**

Liver disease can lead to a shortage of red blood cells, a condition called *anemia*. The hematocrit is used to test for anemia.

#### **hemoglobin (HGB)**

##### **What?**

*Hemoglobin* is the protein inside red blood cells that carries oxygen.

##### **Why Test?**

Liver disease can lead to a shortage of hemoglobin. The hemoglobin test is used to check if there is enough hemoglobin in the blood.

#### **immunoglobulins (Igs)**

##### **What?**

Immunoglobulins are a group of proteins that act as antibodies. Antibodies are one of the two arms of the *immune system*.

##### **Why Test?**

When the Igs are tested in the laboratory, the different proteins of the group are separated and each is measured. The test shows how much of each type of protein is present. Different patterns may point to different problems in the liver. For example, one pattern may indicate liver cell damage, while a different pattern indicates that cirrhosis has developed.

**indirect bilirubin** – see *bilirubin, unconjugated*

**INR** – see *prothrombin time*

#### **iron (Fe)**

##### **What?**

*Iron* is a metal found in red blood cells. It helps red blood cells carry oxygen to all the cells of the body.

**Why Test?**

The liver is one of the main places in the body where iron is stored. When liver cells are damaged, iron is released into the blood. Therefore, the amount of iron in the blood is one way to check how much damage is being done to liver cells by HCV. Iron overload worsens the damage done to the liver by HCV.

**lactate dehydrogenase (LDH)****What?**

*Lactate dehydrogenase (LDH)* is an enzyme found in many cells of the body. It is highly concentrated in red blood cells, liver, heart, and muscle cells.

**Why Test?**

Elevated LDH is one indicator of liver cell damage. However, since it is found in many other cell types, it is usually tested in combination with other liver enzymes.

**LIPA assay** – see *genotyping*

**liver biopsy****What?**

A liver biopsy is a surgical procedure to remove two or three tiny pieces of the liver using a long needle that is inserted into the liver through the skin of the abdomen. The samples are stained and looked at under a microscope.

**Why Test?**

A liver biopsy is the only way to be certain what is happening in the liver as a result of hepatitis C infection. The three main things that will be looked for are *inflammation* (the presence of inflammatory cells in the liver), *fibrosis* (scar tissue that forms when liver cells are destroyed by the virus), and *cirrhosis* (widespread damage to the liver resulting in abnormal liver structure and function). See *Chapter 4.1, Liver Disease Progression* for additional information about liver biopsy and the interpretation of the results.

**5'-nucleotidase (5'NT)****Other Names**

5'-ribonucleotide phosphohydrolase (NTP)

**What?**

*5'-nucleotidase (5'NT)* is an enzyme found in many tissues throughout the body including the liver.

**Why Test?**

5'NT is increased 2 to 6 times the normal amount when bile flow is blocked either inside or outside the liver. Hepatitis, fibrosis, and cirrhosis can block bile flow inside the liver. Gallstones can block bile flow outside the liver.

**partial thromboplastin time (PTT)****Other Names**

activated partial thromboplastin time, APTT

**What?**

A *partial thromboplastin time* is a test to see how quickly blood is able to form a clot.

**Why Test?**

The liver produces many of the proteins needed for clot formation. People with cirrhosis and liver failure may not be able to produce normal amounts of these proteins. The *PTT* is one indicator of the liver's ability to make proteins. It is also important to know if someone cannot form blood clots normally because he or she may not be able to stop bleeding once it starts.

**PCR** – see *HCV polymerase chain reaction*

**platelet count****What?**

*Platelets* are small pieces of cells circulating in the blood. Platelets help form blood clots to halt bleeding.

**Why Test?**

Liver disease can cause a shortage of platelets. The platelet count is used to test for such a shortage, which can lead to easy bruising and uncontrollable bleeding.

**polymerase chain reaction** – see *HCV polymerase chain reaction*

**porphyrins**

**What?**

*Porphyrins* are a group of substances produced in the liver and bone marrow during the process of making a chemical called heme. Heme is the chemical that binds oxygen to red blood cells.

**Why?**

Since the liver is one of two sites for heme production, liver cell damage can interfere with the production of heme. When heme production is abnormal, the substances used to make heme build up in the blood. Testing for porphyrins is a check on how well the liver is performing its job of making heme.

**potassium (K)**

**What?**

*Potassium* is a charged particle called an electrolyte. It is one of the four major electrolytes in the body.

**Why Test?**

Electrolytes perform many important jobs in the body. Two of the most important jobs are regulating the amount of water in your body and keeping your blood pH normal. Some people with hepatitis C hold more water in their bodies than they need. This can cause abnormal potassium levels. This is more likely in people with cirrhosis than in those without cirrhosis.

**prealbumin** – see *transthyretin*

**prothrombin time (PT)**

**Other Names**

INR (International Normalized Ratio), PT/INR

**What?**

*Prothrombin time* (PT) is a test to see how quickly the blood is able to form a clot.

**Why Test?**

The liver produces many of the proteins needed for clot formation. People with cirrhosis and liver failure may not be able to produce normal amounts of these proteins. The PT is one indicator of the liver's ability to make proteins. It is also important to know if someone cannot form blood clots normally because he or she may not be able to stop bleeding once it starts.

PT test reporting is often in the form of a ratio called the International Normalized Ratio or INR. The World Health Organization devised this system to standardize the reporting of PT test results so that no matter what laboratory checks the prothrombin time, the result should be the same.

**PT** – see *prothrombin time*

**PTT** – see *partial thromboplastin time*

**RBC** – see *red blood cell count*

**recombinant immunoblot assay (RIBA)**

**What?**

*RIBA* is a sensitive testing method used to detect the presence of anti-HCV antibodies in the blood.

**Why Test?**

The RIBA test is most often used to confirm a positive result on an EIA (enzyme immunoassay) screening test for anti-HCV antibodies. There are currently three generations of RIBA tests for HCV denoted RIBA-1, RIBA-2, and RIBA-3. For additional information about the significance of a positive test result, see anti-HCV antibodies.

**red blood cell count (RBC)****What?**

Red blood cells carry oxygen from the air we breathe to all of the organs and tissues of the body.

**Why Test?**

Liver disease can lead to a shortage of red blood cells, a condition called anemia. The red blood cell count is used to test for anemia.

**retinol** – see *vitamin A*

**rheumatoid factor (RF)****What?**

Rheumatoid factor is a type of autoantibody. Normally, the body makes antibodies against foreign substances such as bacteria and viruses. Autoantibodies are abnormal antibodies that act against your own cells.

**Why Test?**

More than half of all people with chronic hepatitis C have one or more autoantibodies in their blood. This is important to know because autoantibodies can cause additional symptoms and disease.

**RIBA** – see *recombinant immunoblot assay*

**sodium****What?**

Sodium is a charged particle called an *electrolyte*. It is one of four major electrolytes in the body.

**Why Test?**

Electrolytes perform many important jobs in the body. Two of the most important jobs are regulating the amount of water in your body and keeping your blood pH normal. Some people with hepatitis C hold more water in their bodies than they need. This can cause abnormal sodium levels. This is more likely in people with cirrhosis than in those without cirrhosis.

**T3** – see *triiodothyronine*

**T4** – see *thyroxin*

**thyroid stimulating hormone (TSH)****Other Names**

*thyrotropin*

**What?**

*Thyroid stimulating hormone (TSH)* is produced by the *pituitary gland*. It acts on the thyroid gland to cause it to produce the two thyroid hormones.

**Why Test?**

Some people with hepatitis C develop thyroid problems. Measuring the TSH along with the thyroid hormone levels tells your healthcare provider if the thyroid gland is working normally.

**thyroxin (T4)****What?**

*Thyroxin* is one of two hormones produced by the thyroid gland.

**Why Test?**

Some people with hepatitis C develop thyroid problems. Measuring the thyroxin in the blood is one way to test whether the thyroid gland is working normally.

**TIBC** – see *total iron binding capacity*

**TMA** – see *HCV transcription mediation amplification*

**total bilirubin** – see *bilirubin, total*

**total iron binding capacity (TIBC)**

**What?**

The total iron binding capacity (TIBC) is a measurement of how much iron the blood is able to capture.

**Why Test?**

TIBC is one test used to check the amount of iron in the body. The more iron there is in the body, the lower the TIBC. An abnormally low TIBC means there is too much iron in the body. This is important because iron overload can be seen with chronic hepatitis C. This condition must be treated because iron overload worsens the damage done to the liver by HCV.

**total protein (TP)**

**What?**

Total protein is a measure of all proteins in the blood.

**Why Test?**

The liver produces many of the proteins found in the blood. Measuring the total protein in the blood is one way of testing how well the liver is performing its job of producing proteins.

**transthyretin**

**Other Names**

*prealbumin*

**What?**

*Transthyretin* is a small protein made by the liver. It is used to make the larger protein called albumin.

**Why Test?**

Transthyretin is a sensitive indicator of how well the liver is able to produce proteins. The lower the transthyretin level in the blood, the poorer the liver is performing its job of making proteins.

**triiodothyronine (T3)**

**What?**

*Triiodothyronine* is one of two hormones produced by the thyroid gland.

**Why Test?**

Some people with hepatitis C develop thyroid problems. Measuring triiodothyronine is one way to test whether the thyroid gland is working normally.

**TSH** – see *thyroid stimulating hormone*

**unconjugated bilirubin** – see *bilirubin, unconjugated*

**viral load** – see *HCV polymerase chain reaction and branched DNA test for HCV*

**vitamin A**

**Other Names**

retinol, retinoic acid

**What?**

*Vitamin A* is a fat-soluble vitamin.

**Why Test?**

Absorption of vitamin A from the intestines requires bile. If bile is not being made and secreted normally, the body may not be able to absorb as much vitamin A as it needs. In extreme cases, this can result in night blindness, dry skin, and brittle hair and nails.

**vitamin D**

**Other Names**

ergocalciferol, cholecalciferol

**What?**

Vitamin D is a fat-soluble vitamin.

**Why Test?**

Absorption of vitamin D from the intestines requires bile. If bile is not being made and secreted normally, the body may not be able to absorb as much vitamin D as it needs. Further, liver cells convert absorbed vitamin D into its active form. In cirrhosis and liver failure, the liver may not perform this job normally. In extreme cases, vitamin D deficiency can result in softening of the bones and bone pain.

**vitamin E****Other Names**

alpha-tocopherol

**What?**

*Vitamin E* is a fat-soluble vitamin.

**Why Test?**

Absorption of vitamin E from the intestines requires bile. If bile is not being made and secreted normally, the body may not be able to absorb as much vitamin E as it needs. In extreme cases, vitamin E deficiency can cause a shortage of red blood cells and muscle loss.

**vitamin K****Other Names**

phylloquinone, antihemorrhagic factor

**What?**

*Vitamin K* is a fat-soluble vitamin.

**Why Test?**

Absorption of vitamin K from the intestines requires bile. If bile is not being made and secreted normally, the body may not be able to absorb as much vitamin K as it needs. Vitamin K is required for the production of proteins needed for blood clotting. Vitamin K deficiency can lead to easy bruising and bleeding problems.

**WBC** – see *white blood cell count*

**white blood cell count****Other Names**

WBC count

**What?**

*White blood cells* protect your body against infections. They are part of the body's *immune system*. There are several different kinds of white blood cells including *neutrophils*, *lymphocytes*, and *macrophages*.

**Why Test?**

An elevated white blood cell count often accompanies acute infection. Changes in your white blood cell count may indicate a change in your hepatitis C disease status.

## Summary

Laboratory tests and procedures give a great deal of useful information to your healthcare providers. They can provide information about how well the liver is performing its many jobs, and how much damage HCV is doing to your liver. In deciding what tests you need, your healthcare provider considers several factors, such as:

- How have you been feeling?
- Are you having any new signs or symptoms?
- What treatments or medicines are you taking?
- Where are you in your treatment plan?

Since the answers to these questions are different for each person and may differ from one medical visit to the next, there is no one group of laboratory tests that is considered standard for people living with hepatitis C.

If you have questions about why you need a certain test or what the results mean, ask your healthcare provider. Understanding your laboratory tests can help you understand how your body is responding to HCV and the management plan you have chosen.

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