Hepatitis C Diagnostic Testing

Serologic Antibody Assays

Initial testing for the diagnosis of hepatitis C infection uses serologic assays that detect human antibodies generated as a response to hepatitis C virus (HCV) infection.[1,2,3] A positive HCV antibody test indicates one of following three scenarios: (1) active infection, (2) past HCV infection that has resolved, or (3) a false-positive test.[1,4] None of these anti-HCV antibody tests can differentiate whether the infection is new (acute), chronic, or no longer present.

- **Enzyme Immunoassay (EIA):** The third-generation HCV EIA detects antibodies that bind to recombinant antigens derived from four HCV regions: core, nonstructural 3, nonstructural 4, and nonstructural 5 (Figure 1).[5,6,7] The EIA test is reported as positive or negative based on an absorbance signal compared with a cut-off value.
  - Sensitivity of EIA and False-Negative Results: The third-generation HCV EIA has a sensitivity of approximately 98%.[5,8,9,10] Circumstances associated with a false-negative EIA include patients with acute HCV infection, persons with major immunosuppression (advanced HIV infection or organ transplantation recipients), and persons with chronic renal failure on long-term hemodialysis.
  - Specificity of EIA and False-Positive Results: The third-generation HCV EIA has a reported specificity greater than 99%; false-positive tests can occur with increased gamma globulin production, with autoimmune diseases, and following immunizations.[8] In addition, a false-positive test is more likely when performing widespread testing in populations that have a very low HCV prevalence.

- **Chemiluminescence Immunoassay (CIA):** The CIA test is an antibody test similar to the EIA, but is used less frequently than the EIA test. For the diagnosis of HCV, the CIA has similar sensitivity and specificity as the third-generation EIA.[1,11]

- **Point-of-Care Rapid Immunoassays:** The OraQuick HCV Rapid Antibody Test was FDA approved in 2010 as a point-of-care test for use with whole blood samples obtained either by venipuncture or fingerstick. This OraQuick Rapid Antibody Test can be used as an alternative to the third-generation EIA for initial HCV antibody testing.[12,13,14,15] The OraQuick test is read between 20 to 40 minutes after the test device is inserted into the buffer (Figure 2) and the result is either reactive or nonreactive (Figure 3).[12,13] In 2011, the FDA granted a Clinical Laboratory Improvement Amendments (CLIA) waiver for the OraQuick HCV Rapid Antibody Test. Additional point-of-care rapid HCV antibody tests have been developed but are not approved for use in the United States.[16,17]

- **Recombinant Immunoblot Assay (RIBA):** The HCV RIBA is no longer recommended and is no longer available for use in the United States.[2] The RIBA test identifies specific antibodies generated
in response to HCV antigens (Figure 4) and the test is interpreted as positive (2 or more antigens),
indeterminate (1 antigen), or negative (0 antigens).[7] The RIBA antibody test, when it was available,
was used as a follow-up test in persons who had a positive HCV EIA and a negative HCV RNA test. In
this circumstance, the RIBA could differentiate whether the patient had resolved HCV infection or had
a biologic false-positive EIA.[1]

**Molecular HCV RNA Tests**

Molecular diagnostic tests for hepatitis C specifically detect HCV RNA and the process is commonly referred to
as a Nucleic Acid Test (NAT) or Nucleic Acid Amplification Test (NAAT).[18] The HCV NAT becomes positive
approximately 1 to 2 weeks after initial HCV infection.[19] The NAT test has become the gold standard
supplemental test for patients who have a positive HCV EIA screening test.[2,18] The NAT can determine
whether a patient with a positive HCV antibody test has current (active) or resolved HCV infection.[2,6] In
addition, the NAT can be used in combination with other laboratory studies, such as prior antibody test results
or hepatic aminotransferase levels, to suggest the possibility of acute HCV infection.[19] The results for the
commercially available quantitative HCV RNA assays, which were previously reported as copies/mL, are
now given in International Units (IUs)/mL.[6]

- **Qualitative HCV RNA**: The qualitative HCV RNA tests provide a yes or no answer to whether
detectable HCV RNA is present in the patient blood sample.[18] The qualitative HCV RNA assays are
FDA approved for HCV diagnostic purposes. These tests, however, do not provide a quantitative level
of HCV and are not used for baseline HCV RNA levels or for monitoring response to therapy.[18]
- **Quantitative HCV RNA**: The quantitative HCV RNA tests are not FDA approved for HCV diagnostic
purposes. More recently, however, with the introduction of ultrasensitive HCV quantitative RNA assays
(that detect as few as 5 copies/mL), the quantitative HCV RNA has achieved a similar level of
diagnostic sensitivity as the qualitative assay.[6] In addition, quantitative HCV RNA assays generate
an actual HCV RNA level that may provide useful information as a baseline benchmark in anticipation
of HCV therapy. Because the sensitivity of the quantitative HCV RNA assays has dramatically
improved, many clinicians utilize the quantitative HCV RNA for diagnostic confirmation of chronic HCV
infection.[6] Most often, the quantitative HCV RNA test is used to monitor response to HCV
therapy.[6,18]

**Immunoassays for HCV Core Antigen**

As an HCV diagnostic marker, HCV core antigen has been studied, either alone or as an HCV antibody-HCV
antigen combination assay.[20,21] Some experts have proposed use of an HCV core antigen test as a less
expensive option than HCV RNA testing, but there are no HCV antigen assays (or HCV antigen-antibody
combination assays) that are FDA approved for use in the United States at this time.[22,23]
HCV Testing Sequence

Recommended Testing Sequence

In May 2013, the Centers for Disease Control and Prevention (CDC) published a new recommended testing sequence for diagnosing current (active) hepatitis C infection (Figure 5). This 2013 HCV diagnostic testing sequence recommended by the CDC is not intended for the diagnosis of acute HCV infection. The 2013 recommended testing sequence consists of initial testing for HCV antibody (using either a rapid or laboratory-conducted assay), followed by HCV RNA testing for all positive HCV antibody tests, with the following possible test results.

- **Negative Screening HCV Antibody Test**: Persons who have a negative screening HCV antibody test are considered not infected with HCV and do not need further diagnostic evaluation, unless they have a known risk factor for a false-negative test, such as suspected acute HCV infection, chronic hemodialysis, or an immunocompromising condition, such as HIV infection with a low CD4 cell count.
- **Positive HCV Antibody and Positive HCV RNA**: Individuals who have a positive HCV antibody test and a positive HCV RNA are considered to have current (active) HCV infection.
- **Positive HCV Antibody and Negative HCV RNA**: If an individual has a positive HCV antibody test and a negative HCV RNA assay, they are considered to have no evidence of current HCV infection; in this situation, further testing with a different HCV antibody assay can usually help to differentiate past (resolved) infection from a biologic false positive result.

**Reflexive HCV RNA Testing with Positive Initial HCV EIA**

The CDC encourages setting up a procedure whereby samples that test positive with a laboratory-conducted HCV antibody assay would then undergo reflexive HCV RNA testing, using the same patient blood sample. Many laboratories now offer reflexive HCV RNA testing on HCV antibody-positive samples. The reflexive testing approach is more efficient than other approaches for follow-up HCV RNA testing that include (1) collecting two separate venipuncture samples at the initial blood draw (with the option of ordering the HCV RNA test if the antibody test is positive), or (2) having the patient return for another venipuncture after receiving a positive antibody test result. From a practical standpoint, it is clearly preferable to have the laboratory reflexively perform the HCV RNA testing for positive HCV EIA tests utilizing the same blood sample.
Interpreting and Communicating Test Results

Interpretation of HCV Test Results and Recommended Action

Prior to discussing the HCV test results with the individual who has undergone testing, it is important to interpret the test results and have a plan for communicating the test results and your recommended further action (Figure 6).[2] Individuals who engage in activities, such as injection drug use, that place them at higher risk of acquiring HCV should undergo regular screening for HCV infection.

Negative HCV Antibody

Individuals with a negative HCV antibody test result should be informed they are not infected with HCV, as long as they have not had a potential exposure to HCV in the prior 6 months.[2] If they have not had a potential exposure to HCV in the prior 6 months, they do not need further follow-up HCV testing, unless they have an exposure to HCV in the future.[2]

Positive HCV Antibody and Negative HCV RNA

Individuals with a positive HCV antibody test and a negative HCV RNA should be informed they do not have evidence of current hepatitis C infection.[2] It should be explained to the patient that most likely they were infected at some time with HCV, but cleared the infection on their own and they do not have current infection. They do not need further follow-up HCV testing, unless they had recent (within 6 months) exposure to HCV. A single negative HCV RNA value does not prove that patient is not infected given the potential fluctuations of the viral level early in HCV infection; a follow-up HCV RNA level would be indicated depending on the clinical case. Patients should be reevaluated if they have exposure to HCV in the future.[2]

Positive HCV Antibody and Positive HCV RNA

Individuals with a positive HCV EIA and positive HCV RNA should be told they have evidence of active hepatitis C infection and they should clearly understand they need medical follow-up evaluation and potential treatment of liver disease.[2] A single positive HCV RNA value indicates infection, but must be interpreted in the context of clinical history to determine whether the individual has acute or chronic infection. For persons with a positive HCV EIA and positive HCV RNA, the CDC has generated counseling messages that focus on four areas: (1) contacting a health-care provider for further evaluation and management of their HCV infection, (2) means of protecting their liver from further harm, (3) considerations for overweight and obese persons, and (4) minimizing transmission of their HCV to others (Figure 7).[28] In addition, the CDC recommends performing alcohol screening and brief intervention, which consists of screening for excessive alcohol consumption, brief counseling for individuals who screen positive, and referral to a specialized alcohol treatment program for individuals with possible alcohol dependence.[28]
Linkage to Care

Recommendations Regarding Linkage to Care

All persons identified with active hepatitis C infection (positive HCV RNA) should be linked to a medical provider who can provide competent and comprehensive management of HCV.[28,29] Available data suggest that in the current era, nonspecialists can effectively manage HCV, especially with back-up and consultation for more complicated issues.[30,31,32] The management of patients with decompensated cirrhosis should always involve a hepatologist. In addition, persons with HCV who have renal insufficiency or extra-hepatic complications of HCV infection will likely require referral to a specialist. An individual with positive HCV antibody test but negative HCV RNA level does not require a referral for further evaluation and management of HCV infection.

Recommended Laboratory Evaluation Prior to Referral

All persons referred for further evaluation and management of HCV infection should have a confirmed positive HCV RNA level, preferably a quantitative HCV RNA level (viral load) and not a qualitative HCV RNA level.[29] It is ideal, but not imperative, that the clinician who makes the diagnosis of HCV infection can perform some preliminary tests to provide advanced information in anticipation of the initial referral visit. These initial preliminary tests include an HCV genotype, tests of synthetic liver function (platelet count, total bilirubin, albumin, prothrombin time [PT]), hepatic inflammation (alanine aminotransferase [ALT] and aspartate aminotransferase [AST]), and assays to detect relevant coinfection (hepatitis A antibody, hepatitis B antibody, and HIV antibody). For primary care providers taking on a more comprehensive role for the initial evaluation and management, see Module 2, Lesson 1 for a detailed discussion in the Core Concept Initial Evaluation of Persons with Chronic Hepatitis C.

Gap in Linkage to Care

Unfortunately, many individuals diagnosed with HCV infection (positive HCV RNA) do not get linked to appropriate care for their HCV infection.[33] Multiple reasons for the gap in linkage to care have been cited, including failure of the medical provider to make the referral, lack of medical insurance, and substance use or mental health disorders that interfere with making or keeping the referral appointment. Linkage to care rates have been lower among racial and ethnic minorities. Failure to link to care negatively impacts health outcomes in persons living with HCV infection.[34] With highly effective HCV treatment now available for all HCV genotypes, referral for evaluation and management of HCV has taken on even greater importance.

Strategies for Improving Linkage to Care

Attempts at the public health level to implement an HCV testing and linkage-to-care program have shown that additional funds can be used to leverage existing program and provider networks.[35,36] The CDC and other organizations are actively working to explore strategies, such as the Hepatitis Testing and Linkage to Care (HepTLC) initiative, to enhance linkage to care for persons infected with HCV.[37] It should also be noted that patients who have been previously diagnosed many years ago in the interferon era may have been counseled to not seek treatment given the relatively poor efficacy, long duration, and high rate of adverse effects associated with interferon-based therapy. These patients may require more intensive outreach efforts to educate and update on new greatly improved medications that are now available.
Summary Points

- Diagnostic tests for hepatitis C include serologic assays that measure human antibodies generated in response to HCV infection and molecular virologic assays that directly detect HCV RNA.
- The third-generation HCV EIA test is the most frequently used antibody test to initially screen for HCV infection. The test has high sensitivity and specificity, but does not distinguish between current and resolved hepatitis C infection.
- The OraQuick HCV Rapid Antibody Test is available as a point-of-care rapid test and can be used for initial HCV antibody screening.
- Quantitative HCV RNA assays are the preferred supplemental test for persons who have a positive screening HCV antibody test. Testing positive for HCV RNA indicates current (active) HCV infection. Qualitative HCV RNA assays can be used for supplemental testing but do not offer any advantage over the quantitative assay.
- The 2013 CDC recommended testing sequence for identifying current HCV infection consists of initial HCV antibody testing (either rapid or laboratory-conducted assay) followed by an HCV RNA assay for all positive antibody tests.
- All HCV testing results should be communicated to the person undergoing testing; individuals who have a positive HCV RNA assay should understand they have current (active) hepatitis C infection.
- Individuals who have a positive HCV RNA assay and newly diagnosed hepatitis C should receive preliminary counseling about protecting their liver from further harm, including cessation of alcohol use, strategies for weight loss if they are overweight, and how to minimize their risk of transmitting HCV to others.
- Individuals with newly diagnosed hepatitis C infection should be linked to clinical care for further liver disease evaluation and for potential HCV treatment.
Citations


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Figures

Figure 1 HCV Third-Generation EIA Test

The third-generation HCV EIA is a qualitative test that detects human antibodies. This image shows several combinations of proteins used in different third-generation HCV EIA tests.
**Figure 2 OraQuick HCV Rapid Antibody Test**

This image shows the test device after it has been placed into the buffer in the developer solution vial. The test should be read 20 to 40 minutes after it is placed in the buffer.

Source: Image courtesy of OraSure Technologies, Inc.
**Figure 3 OraQuick HCV Rapid Antibody Test Device**

The OraQuick HCV Rapid Antibody Test can detect HCV antibodies in whole blood (obtained by fingerstick or venipuncture). The test device has control (C) and test (T) zones. If a line is visible only in the C zone (device on left), the test is considered Non-Reactive. If lines are visible in both the T and C zones (device on right), the test is considered Reactive.

Source: Image courtesy of OraSure Technologies, Inc.
**Figure 4 HCV Third-Generation RIBA**

The HCV RIBA is a highly sensitive and specific antibody test, but it is a more complex and expensive test to perform than the HCV EIA. The HCV RIBA is no longer available in the United States.
Figure 5 HCV Testing Sequence for Identifying Current HCV Infection

This diagram shows the HCV testing sequence recommended by the Centers for Disease Control and Prevention in May 2013.

Figure 6 Interpretation of HCV Test Results and Recommended Action

Figure 7 CDC Recommended Counseling for Persons with a Positive HCV RNA Test

The CDC recommends that persons newly diagnosed with HCV infection should receive some basic post-test counseling messages.