# Treatment of Chronic HCV with Direct-Acting Antivirals

Hepatitis C Virus Infection Guideline Committee, July 2017

## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose of this Guideline</td>
<td>1</td>
</tr>
<tr>
<td>Burden of HCV Disease</td>
<td>3</td>
</tr>
<tr>
<td>Role of NYS Primary Care Providers in Treatment of HCV</td>
<td>5</td>
</tr>
<tr>
<td>Development of this Guideline</td>
<td>6</td>
</tr>
<tr>
<td>Screening for HCV Infection</td>
<td>7</td>
</tr>
<tr>
<td>Cohort-Based</td>
<td>8</td>
</tr>
<tr>
<td>Risk-Based</td>
<td>9</td>
</tr>
<tr>
<td>Diagnosis of HCV Infection</td>
<td>14</td>
</tr>
<tr>
<td>Acute HCV Infection</td>
<td>18</td>
</tr>
<tr>
<td>Pretreatment Assessment</td>
<td>20</td>
</tr>
<tr>
<td>Medical History and Physical Exam</td>
<td>21</td>
</tr>
<tr>
<td>Mental Health, Substance Use, and Barriers to Adherence</td>
<td>23</td>
</tr>
<tr>
<td>HCV Genotype</td>
<td>25</td>
</tr>
<tr>
<td>Fibrosis Assessment</td>
<td>26</td>
</tr>
<tr>
<td>Cirrhosis Evaluation</td>
<td>29</td>
</tr>
<tr>
<td>Baseline Laboratory Testing</td>
<td>31</td>
</tr>
<tr>
<td>Cardiac, Renal, HAV/HBV, Pregnancy, and Metabolic Status</td>
<td>32</td>
</tr>
<tr>
<td>Treatment Options</td>
<td>37</td>
</tr>
<tr>
<td>Considerations</td>
<td>38</td>
</tr>
<tr>
<td>Regimens for Retreatment After DAA Failure</td>
<td>58</td>
</tr>
<tr>
<td>Monitoring During DAA Treatment</td>
<td>62</td>
</tr>
<tr>
<td>Drug-Drug Interactions</td>
<td>65</td>
</tr>
<tr>
<td>Elbasvir/Grazoprevir</td>
<td>66</td>
</tr>
<tr>
<td>Glecaprevir/Pibrentasvir</td>
<td>67</td>
</tr>
<tr>
<td>Ledipasvir/Sofosbuvir</td>
<td>68</td>
</tr>
<tr>
<td>Paritaprevir/Ritonavir/Ombitasvir/Dasabuvir</td>
<td>69</td>
</tr>
<tr>
<td>Sofosbuvir</td>
<td>71</td>
</tr>
<tr>
<td>Sofosbuvir and Velpatasvir</td>
<td>72</td>
</tr>
<tr>
<td>Sofosbuvir/Velpatasvir/Voxilaprev</td>
<td>73</td>
</tr>
<tr>
<td>Post-Treatment Care</td>
<td>74</td>
</tr>
<tr>
<td>Treatment of Patients with HIV/HCV Coinfection</td>
<td>77</td>
</tr>
<tr>
<td>All Recommendations</td>
<td>86</td>
</tr>
<tr>
<td>About this Guideline</td>
<td>93</td>
</tr>
<tr>
<td>Funding and Disclosure of Potential Conflicts of Interest</td>
<td>95</td>
</tr>
<tr>
<td>Evidence Collection and Review</td>
<td>97</td>
</tr>
<tr>
<td>Recommendation Development and Rating Process</td>
<td>98</td>
</tr>
<tr>
<td>External Review</td>
<td>99</td>
</tr>
<tr>
<td>Guideline Updates</td>
<td>100</td>
</tr>
</tbody>
</table>
Purpose of this Guideline

Hepatitis C Virus Infection Guideline Committee, July 2017

This guideline on treatment of chronic hepatitis C virus (HCV) infection was developed by the New York State (NYS) Department of Health (DOH) AIDS Institute (AI) to guide primary care providers and other practitioners in NYS in treating patients with chronic HCV infection. The guideline aims to achieve the following goals:

- Increase the number of NYS residents with chronic HCV infection treated with the new direct-acting antiviral (DAA) therapies that cure chronic HCV infection.
- Increase compliance with the 2014 NYS public health law that requires HCV antibody screening be offered to every individual born between 1945 and 1965 who receives healthcare services from a physician, physician assistant, or nurse practitioner in a primary care or inpatient hospital setting.
- Reduce the growing burden of morbidity and mortality associated with chronic HCV infection.
- Integrate current evidence-based clinical recommendations into the HCV-related implementation strategies of the Ending the Epidemic (ETE) initiative, which seeks to end the AIDS epidemic in NYS by the end of 2020.

The NYSDOH AI is publishing these guidelines at a critical time: 1) new treatments are available that can cure chronic HCV infection; 2) the burden of HCV disease is increasing in NYS [CDC 2016]; and 3) primary care providers and other clinical care practitioners in NYS are playing an essential role in screening for and diagnosing chronic HCV infection and in providing state-of-the-art therapy for their patients.

New Standard of Care for Treatment of Chronic HCV Infection

The availability of safe and effective regimens of oral DAAs has revolutionized HCV care. New DAA agents and new combinations of agents continue to be tested and approved, and these efficacious combinations have replaced earlier treatments as the standard of care for curing chronic HCV infection. The DAA regimens make cure possible for many patients, but these patients must first be identified, engaged in care, offered appropriate screening for status of their HCV infection/disease, and have access to treatment.

The goal of HCV therapy is a sustained virologic response (SVR), which is defined as the absence of detectable HCV RNA at least 12 weeks after completion of therapy. An SVR is the equivalent of cure. DAA regimens have been associated with an SVR rate of more than 90% and have excellent tolerability in both treatment-naïve and treatment-experienced patients with and without cirrhosis [Afshah et al. 2014a; Afshah et al. 2014b; Poordad et al. 2016; Poordad et al. 2014; Kwo et al. 2016; Zeuzem et al. 2017; Falade-Nwulia et al. 2017].

References


Burden of HCV Disease

Hepatitis C Virus Infection Guideline Committee, December 2017

First isolated in 1989, HCV is the most common chronic blood-borne infection in the United States [Chen and Morgan 2006; Armstrong et al. 2006], and research suggests that more than 50% of persons with HCV infection are unaware of their infection status [Denniston et al. 2012]. Injection drug use is associated with the highest risk of contracting HCV [Alter 1999, 2007]. Other key routes of HCV transmission include receipt of infected blood or organs (before 1992) or blood products (before 1987), mother-to-child transmission (also known as vertical transmission), sexual transmission, and needle sticks/exposure in healthcare settings [CDC 1998]. According to National Health and Nutrition Examination Study (NHANES) data, among patients participating from 2001 to 2008, the prevalence of HCV infection in persons aged >20 years was 1.3% in the United States. After adjusting for populations not sampled in the NHANES surveys, such as the incarcerated and homeless, the researchers estimated that 3.5 million people were living with chronic HCV infection in the United States [CDC 2013; Edlin et al. 2015]. Approximately 75% of reported cases were among persons born between 1945 and 1965 [Armstrong et al. 2006; Denniston et al. 2012; CDC 2013].

The Centers for Disease Control and Prevention (CDC) reported 162,863 cases of chronic HCV infection (past or present) nationwide in 2015 [Adams et al. 2016]. The number of reported cases in New York State (excluding New York City) and New York City for 2015 are provided in Box 1.

**Box 1: Chronic HCV Infection Cases Reported in New York State and New York City**

<table>
<thead>
<tr>
<th>New York State* [NYSDOH 2016]</th>
<th>New York City [NYCDMH 2016]</th>
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<tbody>
<tr>
<td>• 109,593 cases reported from 2001 to 2015</td>
<td>• 152,030 cases reported from 2001 to 2015</td>
</tr>
<tr>
<td>• 2015 cases: 8,489 reported</td>
<td>• 2015 cases: 7,328 reported, a decrease of 4.7% from 2014</td>
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<td>▪ 38% of cases reported from the 1945 to 1965 birth cohort, with 67% male and 33% female</td>
<td>▪ 49.7% from the 1945 to 1965 birth cohort, with 62.5% male and 37.5% female</td>
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<tr>
<td>▪ 2,302 (27.1%) aged &lt;30 years, with 53% male and 46% female</td>
<td>▪ 886 (12.1%) aged &lt;30 years, with 58% male and 42% female</td>
</tr>
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*excluding New York City

Ensuring access to effective DAA treatment for all individuals with chronic HCV and curing chronic HCV infection in as many as 90% of patients will prevent substantial morbidity and mortality. Approximately 25% to 30% of persons with untreated chronic HCV infection will advance to cirrhosis within 20 to 30 years, with progression occurring more quickly in men, in patients who use alcohol, in those who acquire HCV infection after age 40, and in patients with HIV/HCV coinfection [Klevens et al. 2015; Younossi et al. 2015]. Of those with cirrhosis, >25% will develop end-stage liver disease or hepatocellular carcinoma (HCC), resulting in death if a liver transplant is not received [Klevens et al. 2012].

Chronic HCV infection drives the development of HCC by inducing fibrosis and cirrhosis [El-Serag 2012]. From 1999 through 2013, deaths from primary liver cancer in the United States increased at the highest rate of all cancer sites, and liver cancer incidence rates increased sharply, second only to thyroid cancer [Ryerson et al. 2016]. Men had more than twice the incidence rate of liver cancer than women, and rates increased with age for both sexes. Population modeling performed in 2011 posited that if new antiviral regimens consistently resulted in an 80% response rate, and if 50% of all HCV patients were treated, then, within 10 years, there would be a 15% reduction in cases of cirrhosis, a 30% reduction in cases of HCC, and 34% fewer deaths from liver disease, indicating the substantial effects that treatment would have in reducing liver disease morbidity [Rosen 2011].

In New York State (including New York City), the mortality rate associated with HCV increased from 4.0 per 100,000 population in 2001 to 5.5 per 100,000 population in 2015 [CDC 2016]. The HCV-related mortality rate in New York State surpassed the HIV-related mortality rate in 2012, indicating the severity of disease burden and the urgency for wider treatment availability.
References
Alter MJ. Epidemiology of hepatitis C virus infection. World J Gastroenterol 2007;13(17):2436-41. [PMID: 17552026]
Role of NYS Primary Care Providers in Treatment of HCV

Hepatitis C Virus Infection Guideline Committee, updated July 2018

Primary care providers in NYS are assuming a major role in the screening, diagnosis, treatment, and monitoring of patients with chronic HCV infection. When prescribing HCV antiviral therapy, clinical experience and appropriate continuing education are both important to ensure that HCV medications are prescribed safely and correctly and that all patients receive the highest quality of care.

This guideline covers screening, diagnosis, pretreatment assessment, treatment, and post-treatment monitoring for primary care providers treating patients with chronic HCV infection. In terms of HCV treatment, the guideline includes recommendations for initial HCV treatment in patients with and without cirrhosis and for retreatment in patients with and without cirrhosis who have failed previous DAA and non-DAA regimens.

As stated in these recommendations, care providers new to HCV treatment should consult with a liver disease specialist when treating patients with chronic HCV infection and any of the following conditions:
- Compensated and decompensated cirrhosis
- Concurrent hepatobiliary conditions
- Extrahepatic manifestations of HCV, including renal, dermatologic, and rheumatologic manifestations
- Significant renal impairment (creatinine clearance <30 mL/min) and/or undergoing hemodialysis
- Active hepatitis B (HBV) infection, defined as HBV surface antigen–positive and detectable HBV DNA
- Retreatment after any DAA treatment failure

Care providers should refer patients with chronic HCV infection and decompensated liver disease and patients who are pre– or post–transplant to a liver disease specialist. Depending on their level of experience and expertise, care providers may also want to refer patients who have coexisting conditions (including HIV) that require treatment with complex drug regimens to a liver disease specialist.

### KEY POINT

Care providers should refer patients with chronic HCV infection and decompensated liver disease and patients who are pre– or post–transplant to a liver disease specialist.
Development of this Guideline

Hepatitis C Virus Infection Guideline Committee, July 2017

This guideline was developed by the NYSDOH AI Clinical Guidelines Program, which is a collaborative effort between the NYSDOH AI Office of the Medical Director and the Johns Hopkins University School of Medicine, Division of Infectious Diseases.

Established in 1986, the goal of the Clinical Guidelines Program is to develop and disseminate evidence-based, state-of-the-art clinical practice guidelines to improve the quality of care provided to people with HIV, HCV, and STIs and to improve drug user health and LGBT health throughout the State of New York. NYSDOH AI guidelines are developed by committees of clinical experts through a consensus-driven process.

The NYSDOH AI Hepatitis C Virus Infection Guideline Committee was charged with developing evidence-based clinical recommendations for primary care providers in NYS who treat patients with chronic HCV infection. The resulting recommendations are based on an extensive review of the medical literature and reflect consensus among this panel of HCV experts. Each recommendation is rated for strength and for quality of the evidence (see below). If recommendations are based on expert opinion, the rationale for the opinion is included. See About this Guideline for a full description of the development process, including evidence collection and recommendation development.

<table>
<thead>
<tr>
<th>AIDS Institute HIV Clinical Guidelines Program Recommendations Rating Scheme</th>
<th>Strength of Recommendation</th>
<th>Quality of Supporting Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A = Strong</td>
<td>1 = At least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints</td>
</tr>
<tr>
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<td>B = Moderate</td>
<td>2 = One or more well-designed, nonrandomized trial or observational cohort study with long-term clinical outcomes</td>
</tr>
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<td>C = Optional</td>
<td>3 = Expert opinion</td>
</tr>
</tbody>
</table>
Screening for HCV Infection

Hepatitis C Virus Infection Guideline Committee, July 2017

More than 50% of people with chronic HCV infection may not be aware of their infection [1]. Because approximately 75% of cases are among persons born between 1945 and 1965 [Denniston et al. 2012; Armstrong et al. 2006; CDC 2013], age-cohort screening of asymptomatic adults with no recognized risk factors is thought to increase identification and treatment for these patients. In addition to required HCV screening in the specific birth cohort, healthcare providers should screen patients with other risk factors for HCV infection (see Risk-Based Screening in this guideline).

In May 2018, the AASLD/IDSA updated its HCV Guidance to include a recommendation supporting universal screening for HCV in pregnant women. The HCV Committee of the NYSDOH AI Clinical Guidelines Program agrees with this recommendation.

As part of HCV screening and diagnosis, a series of serologic and virologic tests are used, including laboratory-based antibody tests, point-of-care rapid HCV antibody tests for initial screening, and laboratory-based HCV RNA tests for HCV diagnosis.

**KEY POINT: REPORTING**

- NYS Public Health law mandates that clinicians report all suspected or confirmed cases of HCV infection, specifying acute or chronic, to the local health department of the area where the patient resides.
  - See NYSDOH: Communicable Disease Reporting

References


Cohort-Based Screening

Hepatitis C Virus Infection Guideline Committee, updated July 2018

NEW YORK STATE REQUIREMENT

- REQUIREMENT: NYS Public Health Law mandates that primary care clinicians offer HCV screening to individuals born from 1945 to 1965 in a culturally and linguistically appropriate manner.
  - See NYSDOH: Hepatitis C Testing Law

In NYS, physicians, physician assistants, and nurse practitioners delivering primary care must provide HCV screening, regardless of setting and without regard to certification. Care providers working in hospitals (inpatient units and outpatient clinics) and other healthcare settings where primary care services are being delivered are also required to offer HCV screening. Emergency departments are not required by law to offer HCV screening, but in NYS, they are encouraged to do so.

If the initial screening is reactive, clinicians must offer follow-up healthcare, including HCV diagnostic testing, or refer the patient to a liver disease specialist. By requiring HCV antibody screening for this age cohort in traditional medical settings and supporting screening efforts in community-based locations, NYS is actively seeking to identify people with chronic HCV infection and link them to treatment before irreversible liver damage occurs.

In response to the law, hospitals, clinics, health centers, and other primary care medical facilities have established HCV screening programs. During the first year of implementing the law, there was a 51% increase in specimens submitted for HCV testing. Testing rates among active Medicaid clients increased 52%. Among persons with newly diagnosed HCV infection, linkage to care increased approximately 40% in NYS (excluding New York City) and 11% in New York City [Flanigan et al. 2017].

However, people with HCV infection may face significant barriers to accessing care in clinical settings, including lack of health insurance, physical disability, ongoing substance use, mental health disorders, and housing instability. Locating HCV screening sites in a variety of community-based organizations, such as syringe exchange programs, sexually transmitted disease (STI) clinics, and local health departments, is integral to the effort to provide HCV screening, treatment, and education in diverse settings.

Birth cohort screening is particularly important because patients may not be aware of or remember exposures or may not disclose prior behavioral risks for HCV infection (see Risk-Based Screening in this guideline). Patient education is needed to ensure that patients know about risk factors for transmitting or acquiring HCV infection. While birth cohort screening is important, screening for HCV beyond the required birth cohort is needed in areas where HCV prevalence is high.

- See NYSDOH: Hepatitis C Educational Materials

KEY POINTS

- Cohort and risk-based screening are both crucial to identifying adults with HCV infection.
- In geographical areas with high HCV prevalence, screening should be performed in all people who may have been exposed to HCV through any means of transmission.
- In addition to screening all individuals born from 1945 to 1965, the HCV AI Guidelines Committee agrees with the AASLD/IDSA recommendation to screen all pregnant individuals for HCV.

Reference

Risk-Based Screening

Hepatitis C Virus Infection Guideline Committee, December 2017

**RECOMMENDATIONS**

- Clinicians should perform HCV screening at least once for patients of any age who are not known to have HCV infection and currently have, or have a history that includes, any of the following risk factors:
  - Injection drug use (A1)
  - Intranasal drug use (A2)
  - Sex partner(s) with HCV infection (A2)
  - Incarceration (A2)
  - Long-term hemodialysis (A1)
  - Receipt of blood transfusion or organs before 1992, or of clotting factor concentrates from human plasma before 1987 (A1)
  - A mother with a reactive HCV antibody test result (A1)
  - Tattoo, piercing, or acupuncture obtained in a nonsterile setting (A2)
  - HIV infection (A2)
    - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals Guideline > Treatment of Patients with HIV/HCV Coinfection > Diagnosis of HCV Infection in People with HIV
  - Unexplained liver disease or abnormal transaminase levels (A1)
- Clinicians should offer HCV screening at least annually to individuals who are not known to have HCV infection and:
  - Use injection drugs (A2)
  - Use intranasal drugs (A2)
  - Receive current long-term hemodialysis (A2)
- Clinicians should offer HCV screening at least annually to men who have sex with men (MSM) and to others who are not known to have HCV infection and:
  - Engage in receptive anal sex and other behaviors that may tear mucous membranes (A2)
  - Have multiple sex partners (A2)
  - Engage in sex while using recreational mind-altering substances, particularly methamphetamine (A2)
  - Have been diagnosed with another sexually transmitted infection (STI) within the previous 12 months (A2)
- Clinicians should perform HCV screening for individuals who are not known to have HCV infection and have a possible exposure in a healthcare setting, including those who:
  - Have a break in the skin caused by a sharp object that is contaminated with blood, visibly bloody fluid, or other potentially infectious material or that has been in the source patient's blood vessel (A2)
  - Have been bitten by an individual with visible bleeding in the mouth that causes bleeding in the exposed worker (A2)
  - Have been splashed on a mucosal surface with blood, visibly bloody fluid, or other potentially infectious material (A2)
  - Have non-intact skin (e.g., dermatitis, chapped skin, abrasion, or open wound) that has been exposed to blood, visibly bloody fluid, or other potentially infectious material (A2)

In the United States, an estimated 60% of chronic HCV infections result from use of shared needles, syringes, or other drug-use paraphernalia [CDC 1998]. Overall, sexual transmission accounts for approximately 5% of HCV infections, although transmission rates differ in select groups, as discussed below. Vertical transmission (transmission from mother to child) accounts for 5% to 6% of infection; receipt of contaminated organs or blood component transfusions before HCV testing of the blood supply began in 1992 accounts for approximately 5% of HCV infections [CDC 1998]. The average incidence of anti–HCV seroconversion after unintentional needle sticks or sharps exposures from a source with confirmed HCV infection is estimated at 1.8% [CDC 1998], and HCV infection has also resulted from unsterile skin piercing activities, such as tattoos in prisons (1%) [Alter 1999]. There are a few case reports that might suggest transmission during trauma, including biting [Dusheiko et al. 1990] and fist fighting [Loubiere et al. 2000], when there is potential for blood-to-blood transmission, but there are insufficient data to limit patients with HCV from participating in sports such as boxing or wrestling at this time.
Injection drug use: Sharing of injection drug use (IDU) equipment is an efficient method of transmitting HCV. In the United States, a reduction in new HCV infections between 1992 and 2009 was attributed to expansions of syringe-access programs, safer injection practices among people who inject drugs (PWID), and increased enrollment in drug treatment programs [Klevens et al. 2012]. However, HCV prevalence among PWID entering substance use treatment in New York City (n = 1,535) was 67% (95% confidence interval: 66% to 70%) during the 2006 to 2013 period and was not significantly different from that observed from 2000 to 2001 [Jordan et al. 2015]. The demographics of IDU now include many young people living in suburban and rural regions [Klevens et al. 2012]. Adolescents and young adults may advance to IDU after first becoming addicted to prescription oral opioids [Mateu–Gelabert et al. 2015]. Reports from several states (including New York State), underscore the importance of awareness of HCV risk among adolescent and young adult patients and of offering HCV screening to this population [CDC 2008, 2011a, 2011b, 2012; Zibbell et al. 2015; Pollini et al. 2011].

**KEY POINTS: HCV SCREENING IN ADOLESCENTS AND YOUNG ADULTS**

- Epidemics of HCV infection that parallel opioid-use epidemics have been observed among young male and female injection drug users, primarily in suburban and rural areas [CDC 2008, 2011a, 2011b, 2012; Zibbell et al. 2015; Pollini et al. 2011].
- HCV screening should be offered to at-risk adolescents and young adults.
- In 2015, 2,309 (27.2%) of HCV cases reported in New York State (excluding New York City) were in people <30 years of age [NYSDOH 2016]. Among those <30 for whom risk information is available, 91% reported a history of IDU.

Intranasal drug use: In a systematic review of 28 studies on the prevalence of HCV in noninjecting drug users who smoked, sniffed, or snorted such drugs as heroin, powder or crack cocaine, or methamphetamine, investigators found HCV prevalence rates ranging from 2.3% to 35.3% [Stern et al. 2008; Scheinmann et al. 2007]. Among noninjecting drug users, sharing of oral and nasal drug use equipment is associated with an increased risk of HCV infection [Macias et al. 2008; Koblin et al. 2003; Neaigus et al. 2007]. In addition, blood and HCV RNA have been confirmed in the nasal secretions and drug-sniffing paraphernalia of intranasal drug users with HCV infection [Aaron et al. 2008].

Sexual transmission: Because many with HCV infection have a history of drug use, estimation of sexual transmission is a challenge (as reviewed in [Tohme and Holmberg 2010]). Sexual transmission of HCV among monogamous heterosexual couples is infrequent. The estimated maximum prevalence of HCV infection among sex partners of individuals with chronic HCV infection was only 1.2%, and the maximum incidence of HCV transmission through sex contact was 0.07% per year or approximately 1 per 190,000 sexual contacts [Terrault et al. 2013]. Sexual transmission risk increases in the setting of multiple partners, STIs, HIV, and exposure to blood [Tohme and Holmberg 2010]. Several reports have demonstrated isolated outbreaks of sexual HCV transmission among MSM with HIV infection who engage in receptive anal intercourse [CDC 2011b; Urbanus et al. 2009; van de Laar et al. 2009; Wandeler et al. 2012]. In a report from New York City on sexual transmission among MSM with HIV and no previous history of injection drug use, new HCV infections were highly correlated with receptive anal intercourse, engaging in sex while using methamphetamine, or participating in group sex [CDC 2011b].

History of incarceration: Incarcerated populations are a significant but declining portion of the HCV epidemic in the United States [Varan et al. 2014; Larney et al. 2013; Alvarez et al. 2014]. A study from 2009 to 2013 at two maximum-security prisons in New York State estimated an HCV prevalence of 10.1%; injection drug use, being the partner of a PWID, and HIV diagnosis were most strongly associated with HCV infection [Alvarez et al. 2014]. In 2015, 22.2% of newly reported cases of chronic or acute HCV infection in New York State (excluding New York City) had a reported history of incarceration [NYSDOH 2016]. In New York City, the rate of newly reported chronic HCV infection in 2015 was 86.3 per 100,000. In the incarcerated population of the city, the rate was 964.3 per 100,000 for the same year [NYCDHMH 2015].

**Exposure to blood in a healthcare setting:** The average incidence of anti–HCV seroconversion after unintentional needle sticks or sharps exposures from a source with HCV infection is 1.8% [CDC 1998]. Healthcare–related transmission of HCV is documented infrequently in the United States [Henderson 2003; Tomkins et al. 2012].
In 2014, among reported acute HCV cases that included information on exposure type, 1% was considered to be occupationally acquired [CDC 2017b].

**Hemodialysis:** The estimated 8% prevalence of anti-HCV antibodies among chronic hemodialysis patients is significantly higher than the estimated 1.6% prevalence in the general U.S. population [CDC 1998]. Nationally, 36 cases of acute HCV infection in 19 different hemodialysis clinics in 8 states were reported between 2014 and 2015, with epidemiologic and viral sequencing confirming transmission between patients [CDC 2016]. The Centers for Disease Control and Prevention (CDC) recommend HCV antibody screening upon admission for chronic hemodialysis patients, followed by screening every 6 months thereafter [CDC 2016, 2017a]. The National Kidney Foundation stratifies by prevalence and recommends antibody screening upon admission to facilities with a low HCV prevalence and consideration of HCV RNA testing upon admission to facilities with high HCV prevalence [KDIGO 2008].

**Receipt of blood transfusion or organ transplant before 1992 or clotting factor concentrates from human plasma before 1987:** Donor screening for HCV infection and inactivation procedures for pooled plasma and plasma derivative products have virtually eliminated the risk of HCV transmission through blood products in the United States [CDC 1998; Watson et al. 1992].

**Vertical transmission:** A 2011 meta-analysis estimated that the risk of vertical HCV infection to children of HCV antibody–reactive and HCV RNA detectable women was 5.8% for children of women without HIV and 10.8% for children of women with HIV [Arshad et al. 2011]. From 2011 to 2014, the national rate of HCV infection among women of childbearing age (15–44 years old) increased by 22% (from 139 to 169 per 100,000), and the national rate of infants born to women diagnosed with HCV infection increased by 68% (from 0.19% to 0.32%) [Koneru et al. 2016]. Factors associated with an increased risk of perinatal transmission include HIV coinfection and higher maternal HCV viral loads [Arshad et al. 2011; Benova et al. 2014]. Neither delivery by cesarean-section nor refraining from breastfeeding has been demonstrated to reduce vertical transmission [Koneru et al. 2016].

**Tattoos, piercings, or acupuncture obtained in nonsterile settings:** Tattoos or piercings obtained in nonsterile settings, and especially those obtained during incarceration, have been associated with HCV infection, even after controlling for injection drug use and transfusion before 1992 [Carney et al. 2013; Tohme et al. 2012]. Low levels of HCV RNA have been detected on acupuncture needles from individuals known to have HCV infection [Lemos et al. 2014], although acupuncture has not been established as a confirmed route of transmission.

**HIV infection:** HCV infection is common among persons with HIV because the routes of acquisition are similar. For decades, injection drug use has been recognized as the main risk factor for HIV/HCV coinfection, but an increasing number of sexually transmitted HCV infections have been documented in MSM with HIV [Hagan et al. 2015; Fierer and Factor 2015; Breskin et al. 2015]. In a recent study among MSM with HIV in Europe, Australia, and Canada, HCV incidence significantly increased from 1990 to 2014 [van de Laar et al. 2009]. Analyses of data from the Multicenter AIDS Cohort Study (MACS) in the United States and from a cohort of MSM with HIV in San Diego demonstrated a similar rise in HCV incidence among MSM [Witt et al. 2013; Chaillon et al. 2017]. In this population, sexual acts that may tear mucous membranes, sex while using methamphetamines, and having other STIs have been associated with HCV infection [Hagan et al. 2015; Fierer and Factor 2015].

**Unexplained liver disease or abnormal transaminase levels:** In primary care patients with an alanine transaminase (ALT) level 50 to 100 IU/L, HCV prevalence is 10-fold higher than in the general population, whereas hepatitis B (HBV) prevalence was not increased [Helsper et al. 2012].

**References**


Fierer DS, Factor SH. Defining the Scope of Sexually Transmitted Hepatitis C Virus Epidemic Among HIV–Infected Men Who Have Sex With Men in New York City. Sex Transm Dis 2015;42(7):400–1. [PMID: 26222756]


Diagnosis of HCV Infection
Hepatitis C Virus Infection Guideline Committee, December 2017

∪ RECOMMENDATIONS

Screening Tests
- Clinicians should perform HCV screening using either a laboratory-based HCV antibody test or point-of-care rapid antibody test. (A1)
  - For the HCV testing sequence in patients with HIV and CD4 cell counts <200 mm$^3$, see NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Treatment of Patients with HIV/HCV Coinfection > Diagnosis of HCV Infection in People with HIV

Confirmatory Testing
- If the HCV antibody test result is reactive, clinicians should obtain confirmatory HCV RNA testing from a laboratory that uses a nucleic acid test (NAT) approved by the U.S. Food and Drug Administration (FDA). (A1)
- If HCV RNA is detected after a reactive antibody result, the patient has confirmed HCV infection and clinicians should evaluate for treatment of chronic or acute HCV infection. (A2)
- If the HCV antibody test result is nonreactive:
  - Clinicians should perform subsequent HCV screening based on individual patient risk factors (A3)
  - And if acute HCV infection is suspected, clinicians should perform a diagnostic HCV RNA test using an FDA-approved NAT (A1)
- In patients with a history of a reactive HCV antibody test, clinicians should use an HCV RNA test (not an HCV antibody test) for subsequent screening. (A1)

⇒ NEW YORK STATE PUBLIC HEALTH LAW

- Beginning in January 2014, NYS public health law requires that HCV antibody screening be offered to every individual born between 1945 and 1965 who receives healthcare services from a physician, physician assistant, or nurse practitioner in a primary care or inpatient hospital setting [NYSDOH unpublished data].
- HCV screening is required unless the healthcare practitioner believes that: 1) the individual is being treated for a life-threatening emergency, 2) the individual has previously been offered or has received an HCV screening test, or 3) the individual lacks capacity to consent to a HCV screening test.

HCV Antibody Testing

HCV antibody testing is the first step in identifying whether a person has been exposed to the virus [CDC 2013] (see Centers for Disease Control and Prevention [CDC]: Recommended Testing Sequence for Identifying Current HCV Infection).

HCV antibody testing with a third-generation enzyme immunoassay (EIA) is most frequently performed in the laboratory; this test has a sensitivity of approximately 99% even when used in low-prevalence populations [Lee et al. 1995; Abdel-Hamid et al. 2002; Gretch 1997; Colin et al. 2001].

Reflex testing is an automatic HCV RNA test of the same specimen that is performed after a reactive HCV antibody test. This testing provides confirmation or exclusion of active infection with a single laboratory test order, eliminating the need for the patient to return for follow-up testing and expediting linkage to care for those who have HCV (see Table 1: Interpretation of HCV Test Results, below). Knowledge of the laboratory’s HCV reflex testing procedures is necessary, including the availability of reflex testing and, if available, whether is it performed automatically or must be requested. If reflex testing is not available, confirmatory HCV RNA testing should be performed soon as possible after a reactive HCV antibody test result is received.
Rapid, point-of-care HCV antibody screening tests are also available; they can be performed with a finger stick blood sample and produce results within 20 to 40 minutes. Sensitivities and specificities are equivalent to traditional EIA testing [Lee et al. 2010]. The NYSDOH HCV Rapid Testing Program and others are using this simple and convenient testing method outside of traditional healthcare settings in drug treatment centers, syringe-exchange programs, and other community-based locations. The short testing process means the test can be performed and the result given while the patient is still present, and, if the patient is HCV antibody-positive, the follow-up appointment for confirmatory HCV RNA testing can be made.

If the HCV antibody test is nonreactive, the immunocompetent patient does not have chronic HCV infection; ongoing individual risk factors will determine the need for future screening and the need for ongoing education about risk-reduction strategies. However, a false-negative (false-nonreactive) antibody test result may occur in patients who may have been exposed to the virus within the previous 6 months and may be experiencing acute HCV infection (see Acute HCV Infection in this guideline) [Nastouli et al. 2009]. HCV RNA is usually detectable within days to 2 weeks after an exposure [Maheshwari and Thuluvath 2010; Wang et al. 2002], whereas it may take 2 to 6 months for HCV antibodies to be detectable (“window period”). False-nonreactive antibody test results may also occur in patients who are immunocompromised due to advanced HIV infection, use of immunosuppressive therapy, long-term hemodialysis, or other conditions [Larouch et al. 2012; Thomson et al. 2009]. In these patients, confirmatory HCV RNA testing should be performed.

If the HCV antibody test is reactive, confirmatory HCV RNA testing should be performed [Freiman et al. 2016; Moorman et al. 2017]. It is important to inform patients that the reactive antibody result does not confirm active HCV infection.

**HCV RNA Testing**

FDA-approved HCV RNA tests are available, and these tests can identify the presence of virus as early as 2 weeks post-exposure, rather than the 8 to 24 weeks needed for HCV antibodies to develop [Kamili et al. 2012] (see American Association for the Study of Liver Disease (AASLD): FDA-approved, Commercially Available Anti-HCV Screening Assays). Ultrasensitive HCV quantitative RNA assays can detect as few as 5 copies/mm$^3$.

If HCV RNA is not detected after a reactive antibody test, then 1) the patient had previous exposure to HCV but has cleared the virus and does not have active HCV infection, or 2) the result of the HCV antibody test was falsely-reactive. In these patients, ongoing HCV screening should occur based on individual risk factors. Because the presence of HCV antibodies can be lifelong, detection of current HCV infection in antibody-reactive patients requires HCV RNA testing. Repeat HCV antibody testing is not useful in patients with previously reactive antibody tests.

If HCV RNA is detected after a reactive antibody result, the patient has confirmed HCV infection and should be evaluated for treatment of chronic or acute HCV infection (see Pretreatment Assessment in this guideline). It is important to advise all patients with HCV viremia that they may be infectious and should take precautions to avoid transmitting HCV to others.

**KEY POINTS: HCV ANTIBODIES**

- The presence of HCV antibodies alone may not indicate active HCV infection.
- In patients with a history of a reactive HCV antibody test, subsequent screening requires an HCV RNA test, not an HCV antibody test, to detect infection.
- HCV antibodies do not prevent future HCV infections; prevention measures are needed for those with ongoing risk factors.
Table 1: Interpretation of HCV Test Results*

<table>
<thead>
<tr>
<th>Anti-HCV Antibody</th>
<th>HCV RNA</th>
<th>Interpretation</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>Detected</td>
<td>• Acute or chronic HCV infection</td>
<td>• Evaluate for treatment</td>
</tr>
</tbody>
</table>
| Positive          | Not detected| • Resolution of HCV by spontaneous or treatment–related clearance, or | • HCV RNA testing based on risk factors  
|                   |         | • HCV infection during period of intermittent viremia, or | • Repeat HCV RNA testing if acute exposure is known or suspected  
|                   |         | • False positive antibody screening result | |
| Negative          | Detected| • Early acute HCV infection, or | • Evaluate for treatment if person has risk factors  
|                   |         | • Chronic HCV infection in setting of immunosuppressed state | • Repeat testing if person has no risk factors or exposure and false positive is suspected  
| Negative          | Unknown | • Presumed absence of HCV infection if the HCV RNA testing was not performed or the status is unknown | • HCV antibody test based on risk factors |

*Adapted from CDC 2013.

References


New York State Department of Health (NYSDOH) AIDS Institute, unpublished data.


Acute HCV Infection
Hepatitis C Virus Infection Guideline Committee, December 2017

**RECOMMENDATIONS**

- Clinicians should suspect acute HCV infection if a patient who had a nonreactive antibody test documented within the previous 6 months has a new reactive antibody test or has detectable HCV RNA in the absence of a reactive antibody test. (A3)
- Clinicians should not prescribe pre- or post-exposure prophylaxis to prevent HCV infection. (A1)
- If chronic HCV infection is established, clinicians should evaluate patients for treatment. (A1)
  - See NYSDOH AI guideline *Treatment of Chronic HCV with Direct-Acting Antivirals* > Pretreatment Assessment
- Clinicians should screen all patients with possible acute HCV infection for HIV, hepatitis A virus (HAV), and hepatitis B virus (HBV) infections, given the similar risk factors for acquisition. (A3)
  - See NYSDOH AI guideline *Treatment of Chronic HCV with Direct-Acting Antivirals* > Pretreatment Assessment
  - Baseline Laboratory Testing

**KEY POINTS**

- Clinicians and their patients should determine the timing of HCV treatment with respect to the likelihood of spontaneous clearance and patient or care provider concerns regarding risk of transmission.
- Patient education should include the following information:
  - If patients have acute HCV infection, they may be infectious and should take precautions to avoid transmitting HCV to others.
  - HCV infection may clear spontaneously (i.e., without treatment).
  - Treatment options are available if HCV infection is established.

The acute phase is considered the first 6 months of HCV infection. Approximately 65% to 75% of patients with acute HCV infection are asymptomatic [Marcellin 1999]. When symptoms are present, they last a few weeks to months after exposure and may range from a clinical hepatitis with jaundice, choluria (tea-colored urine), steatorrhea, and abdominal pain to only vague, nonspecific symptoms, such as fatigue, anorexia, low-grade fever, myalgias, arthralgia, mood disturbances, and nausea or vomiting [Marcellin 1999; Gerlach et al. 2003; Loomba et al. 2011]. As a result, in the absence of a clearly defined risk factor for transmission, the acute phase is rarely diagnosed. During acute infection, serum aminotransferase levels also vary and may be normal or up to 20 times the upper limit of normal [Maheshwari and Thuluvath 2008].

An estimated 20% to 45% of patients with HCV infection will clear the virus spontaneously, generally within 12 to 16 weeks [Kamal 2008]. Approximately 11% of those who remain viremic 6 months after infection will eventually experience spontaneous clearance [Seeff 1997]. Predictors of spontaneous clearance include female sex, age <40 years, IL28B CC genotype (highest incidence in East and South Asians and Europeans, lowest in African Americans), symptomatic infection (jaundice), and a competent immune system (no immunosuppressive therapy or uncontrolled HIV) [Grebely et al. 2014]. Because both aminotransferases and HCV viral load may fluctuate during the acute phase, durable spontaneous clearance, if it occurs, is not expected until 24 weeks after inoculation or exposure. Following spontaneous clearance, patients will remain antibody reactive.

**Known exposure:** After a known exposure, which generally occurs in an occupational setting, baseline testing with both HCV RNA and antibody tests is reasonable to distinguish between acute or chronic infection.

Given the excellent response rates with current DAA therapy, at this time, there is no clear advantage to treatment of HCV in the acute phase [Naggie et al. 2017]. It is reasonable to wait a minimum of 24 weeks to repeat HCV RNA and antibody tests to assess for spontaneous clearance or confirm infection. In some circumstances, clinicians and their patients may decide to initiate therapy sooner; however, if patients have an increased risk of transmitting...
HCV, are HIV-infected men who have sex with men (MSM), and/or use injection drugs, a minimum of 12 to 16 weeks is needed to assess for spontaneous clearance before initiation of therapy. Other factors influencing decisions to initiate early treatment may be current access to healthcare, concerns for delay due to family planning, and known cirrhosis or preexisting liver disease. The recommended DAA regimens used in these situations are the same as those indicated for chronic HCV therapy.

It is important to educate patients with potential acute HCV infection about the possibility of spontaneous clearance, the need to avoid or minimize hepatotoxic drugs (including alcohol), and the need to take precautions to prevent HCV transmission to others (see patient education information at NYSDOH AI HCV Educational Materials).

References
Pretreatment Assessment

Hepatitis C Virus Infection Guideline Committee, December 2017

RECOMMENDATIONS

Who to Assess for Treatment

- Clinicians should assess all patients with a confirmed diagnosis of chronic HCV infection for treatment. (A1)

When to Refer to a Liver Specialist

- Clinicians new to treating chronic HCV infection should consult with a liver disease specialist when treating chronic HCV infection in patients with any of the following conditions (A3):
  - Compensated and decompensated cirrhosis
  - Concurrent hepatobiliary conditions
  - Extrahepatic manifestations of HCV, including renal, dermatologic, and rheumatologic manifestations
  - Significant renal impairment (creatinine clearance <30 mL/min) and/or undergoing hemodialysis
  - Active hepatitis B virus (HBV) infection, defined as HBV surface antigen positive and detectable HBV DNA
  - Ongoing HCV infection after failure of treatment with direct-acting antivirals (DAAs)

- Clinicians new to treating chronic HCV infection should consult with a liver disease specialist when evaluating patients for retreatment after any DAA treatment failure. (B3)
  - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Regimens for Retreatment After DAA Failure

- Clinicians should refer patients with chronic HCV infection and decompensated liver disease and patients who are pre- or post-transplant to a liver disease specialist (A3)

With few exceptions, all patients with confirmed HCV infection are candidates for treatment [Simmons et al. 2015; Smith-Palmer et al. 2015; van der Meer et al. 2012]. Treatment of HCV reduces all-cause mortality, regardless of disease stage [Simmons et al. 2015]. The only patients who are not candidates for treatment with DAAs are those with a life expectancy of less than 12 months or for whom treatment would not improve symptoms or prognosis [AASLD/IDSA HCV Guidance Panel 2015].

References


Medical History and Physical Exam

Hepatitis C Virus Infection Guideline Committee, updated July 2018

The patient's medical history and physical examination are essential components of pretreatment assessment. Table 2, below, lists elements of the patient history and physical examination that apply specifically to pretreatment assessment of patients with chronic HCV infection.

Screening of mental health status and for alcohol/substance use and treating or referring patients with disorders is an essential component of patient care. The approach to patients with mental health or substance use disorders is the same for patients with HCV as for other patients. Mental health conditions that have been stabilized and substance use disorders that are being treated are not contraindications to HCV treatment.

<table>
<thead>
<tr>
<th>Table 2. Key Elements of a Pre-HCV Treatment Patient History and Physical Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elements of Patient History</strong></td>
</tr>
<tr>
<td>Previous treatment for HCV infection</td>
</tr>
<tr>
<td>History of hepatic decompensation</td>
</tr>
<tr>
<td>History of renal disease</td>
</tr>
</tbody>
</table>
| Medication history and current medications, including over-the-counter and herbal products | • Carefully consider drug–drug interactions with DAAs  
  ▫ See Drug–Drug Interactions in this guideline |
| Pregnancy status and plans | • HCV treatment is deferred during pregnancy  
  ▪ Birth control use is essential during HCV treatment and for 6 months after treatment if patients are receiving ribavirin (RBV) |
| HIV infection | • If HIV infection is confirmed, offer patient antiretroviral therapy (ART)  
  ▫ See NYSDOH AI guideline When to Initiate ART  
  ▪ If the patient is being treated with antiretroviral medications, assess potential drug–drug interactions  
  ▫ See Treatment of Patients with HIV/HCV > Drug–Drug Interactions between DAAs and ARVs in this guideline  
  ▪ Presence of HIV infection may influence fibrosis assessment modality, choice of treatment, duration, and monitoring |
| History of infection/vaccination status | • Hepatitis A virus (HAV): Obtain HAV antibody (immunoglobulin [IgG] or total)  
  ▪ Hepatitis B virus (HBV): Obtain hepatitis B surface antigen (HBsAg), antibody to HB surface antigen (anti–HBs), and anti–hepatitis B core antibody (anti–HBe) (total)  
  ▪ Administer pneumococcal polysaccharide vaccination (PPSV23) as follows:  
    ▫ All patients with cirrhosis, which is associated with increased susceptibility to bacterial infections [Jalan et al. 2014]  
    ▫ Patients aged 19 to 64 years  
    ▫ As a 1-time revaccination 5 years after the first dose of PPSV23  
    ▫ Patients aged 65 or older who received 1 or 2 doses of PPSV23 before age 65 years for any indication, if at least 5 years have passed since their previous dose  
  ▪ Annual influenza  
  ▫ See U.S. Food and Drug Administration (FDA): Influenza Virus Vaccine Safety & Availability |
<table>
<thead>
<tr>
<th>Elements of a Pretreatment Physical Examination</th>
<th>Clinical Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence or absence of ankle edema, abdominal veins, jaundice, palmar erythema, gynecomastia, spider telangiectasia, ascites, encephalopathy, and asterixis</td>
<td>• Presence may suggest cirrhosis or decompensated cirrhosis and may require additional evaluation and management or treatment</td>
</tr>
</tbody>
</table>
| Presence or absence of physical signs related to extrahepatic manifestations of HCV, such as porphyria cutanea tarda, vasculitis, or lichen planus | • Presence may increase urgency of HCV treatment and may require additional evaluation and treatment needs  
   ▪ See, for instance, Medscape: Cutaneous Manifestations of HCV Clinical Presentation |
| Liver size by palpation or auscultation for hepatomegaly or splenomegaly, as well as tenderness or hepatic bruits | • Size and tenderness may suggest severity of liver disease and may require additional evaluation |
| Cardiac status | • Findings may influence choice of RBV-containing regimen, RBV dosing, or complete blood count (CBC) monitoring frequency |

Reference

Mental Health, Substance Use, and Barriers to Adherence

Hepatitis C Virus Infection Guideline Committee, December 2017

Mental Health

If stabilized, mental health disorders are not contraindications to treatment of chronic HCV infection with direct-acting antivirals (DAAs). Strategies to overcome mental health–related barriers to successful HCV treatment include counseling and education and referral to psychiatry and behavioral health services. Patients with mental health disorders may need increased attention to management of adverse effects and coordination of care during HCV treatment. An integrated care model, in which mental health providers provide HCV treatment and risk reduction counseling, has been effective for treating HCV [Groessl et al. 2013]. Few data are currently available regarding the effect of an existing psychiatric diagnosis on patient adherence to any oral HCV treatment regimens.

With interferon–free regimens, depression is no longer a common side effect of HCV treatment. However, antidepressant and antipsychotic drug–drug interactions have been reported with DAAs, so monitoring is necessary. Similarly, it is important to be aware of patient use of nonprescription medication: St John’s wort, an herbal self-remedy for depression, may decrease the effectiveness of DAA therapy [FDA 2015a, 2015b, 2015c, 2016].

▪ See Drug–Drug Interactions in this guideline.

Alcohol and Other Substance Use

A history, or active use, of alcohol, tobacco, marijuana, and other substances is not a contraindication to HCV treatment unless the drug or alcohol use is believed to interfere with adherence to medications or appointments. Studies have demonstrated that active substance users who are receiving addiction treatment can be effectively treated for chronic HCV infection [Jerkeman et al. 2014; Alavi et al. 2013; Bojovic et al. 2013; Newman et al. 2013; Brunner et al. 2013; Seidenberg et al. 2013; Dore et al. 2015; Dore et al. 2016].

Once a patient’s alcohol consumption habits have been assessed, counseling may help the patient to reduce or eliminate alcohol use [EASL 2015]. It is important for patients with HCV infection who use alcohol to be made aware of the effects of alcohol on the course of HCV disease. Alcohol use has been associated with increased rates of liver disease progression and hepatocellular carcinoma (HCC) in persons with chronic HCV infection. In one such study, the risk of end–stage liver disease was higher in patients who reported ingesting more than 260 g (approximately 9 ounces) of alcohol per week [Vandenbulcke et al. 2016]. Moderate alcohol intake is also associated with an increased risk of fibrosis progression [Westin et al. 2002], and light–to–moderate alcohol intake is associated with an increased risk of HCC in patients with compensated cirrhosis [Vandenbulcke et al. 2016]. There is no consensus on a safe level of alcohol ingestion for persons with chronic HCV infection, and no evidence is currently available regarding the effects of alcohol use on response to DAA treatment. Abstinence has been associated with improvement in chemical markers and decreased HCV RNA levels among previously heavy drinkers with HCV infection [Cromie et al. 1996; Lieber 2001].

Barriers to Adherence

Though HCV treatment regimens are relatively short in duration, assessing a patient’s readiness for treatment and ability to adhere to medications and medical appointments before initiating DAA therapy is essential. The purpose of the adherence assessment is to optimize support, not to deny access to treatment. After the pretreatment assessment and before treatment initiation, a plan can be developed with the patient to address potential barriers and/or to put support resources in place. Support groups and peer programs can promote increased patient engagement.

KEY POINTS

▪ The purpose of the adherence assessment is to optimize support, not to deny access to treatment.
▪ Though HCV treatment regimens are relatively short in duration, assessing a patient’s readiness for treatment and ability to adhere to a medication regimen and medical care appointments before initiating DAA therapy is essential.
▪ After the pretreatment assessment and before treatment initiation, a plan can be developed with the patient to address potential barriers and/or to put support resources in place.
References


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FDA. Harvoni (ledipasvir and sofosbuvir) tablets, for oral use. 2015b Mar. https://www.accessdata.fda.gov/drugsatfda_docs/label/2015/205834s001lbl.pdf [accessed 2017 Dec 18]


HCV Genotype
Hepatitis C Virus Infection Guideline Committee, July 2017

**RECOMMENDATIONS**

- Clinicians should obtain HCV genotype/subtype testing for all patients before starting treatment with DAAs. (A1)

HCV genotype influences the choice of DAA regimen and treatment duration in patients with chronic HCV infection; therefore, HCV genotype/subtype testing is needed for all patients being considered for HCV therapy [AASLD/IDSA HCV Guidance Panel 2015]. There are 6 common HCV genotypes and over 100 subtypes [Chevaliez and Pawlotsky 2007]. Approximately 70% of chronic HCV infections in the United States are genotype 1, the majority of which are subtype 1a [CDC 1998].

**References**


Fibrosis Assessment
Hepatitis C Virus Infection Guideline Committee, December 2017

RECOMMENDATIONS

▪ Clinicians should assess the degree of fibrosis in patients with chronic HCV infection to aid in determining the following (A1):
  ▫ Need for pretreatment screening for varices and hepatocellular carcinoma (HCC)
  ▫ Duration of antiviral treatment
  ▫ Need to include ribavirin (RBV) in the treatment regimen
  ▫ Need for post-treatment follow-up
▪ Clinicians should assess patients with chronic HCV infection for decompensated liver disease. (A1)
▪ Clinicians should refer patients with decompensated cirrhosis to a liver disease specialist. (A3)

Fibrosis stage predicts HCV treatment response [Ogawa et al. 2015]. An assessment of the degree of fibrosis should be performed regardless of alanine aminotransferase (ALT) patterns because significant fibrosis may be present in patients with repeatedly normal ALT [EASL 2015]. In one study, approximately 50% of HCV–infected persons born between 1945 and 1965 had severe fibrosis or cirrhosis as measured by fibrosis (FIB)-4 scoring [Klevens et al. 2015]. It is particularly important to identify patients with bridging fibrosis or cirrhosis; these findings may influence treatment selection and duration and may dictate post–treatment follow-up, such as the need for ongoing assessment for esophageal varices, hepatic function, and surveillance monitoring for HCC [Bruix and Sherman 2011; Garcia–Tsao et al. 2007; AASLD/IDSA HCV Guidance Panel 2015]. Patients with lower severity of fibrosis have a higher likelihood of response to therapy and improved post–treatment prognosis [EASL 2015]. Patients known to have cirrhosis do not require repeat determination of degree of fibrosis before treatment.

Fibrosis stage can be assessed using noninvasive modalities, such as transient elastography, aspartate aminotransferase–to–platelet ratio index (APRI), FIB–4, and assays of direct markers of liver fibrosis using noninvasive tests other than transient elastography in patients with coinfection (see Table 3: Methods for Staging Fibrosis, below, and Treatment of Patients with HIV/HCV Coinfection > Pre–HCV–Infection Treatment Assessment of Fibrosis in Patients with HIV in this guideline). Noninvasive modalities are well suited for rapid pretreatment assessment of chronic HCV infection in the primary care setting. Indirect serum markers use mathematical algorithms with different variables to predict fibrosis and are easily accessible in the primary care setting. Tests such as the APRI and FIB–4 index (age, AST, ALT, platelet count) appear efficacious in patients with little or no fibrosis and in those with cirrhosis. However, these tests have limited ability to discriminate between intermediate stages of fibrosis [Castera et al. 2014; Patel and Shackel 2014; Schiavon et al. 2014]. Several studies have found FIB–4 to predict fibrosis more accurately than APRI [Amorim et al. 2012; Shaikh et al. 2009].

Liver biopsies are not routinely required. They are useful for patients with highly discordant results on noninvasive testing and in patients suspected of having a second etiology for liver disease in addition to HCV infection. Liver biopsy is an important instrument for diagnosing concurrent disease, such as metabolic nonalcoholic steatohepatitis (NASH), hemochromatosis (HHC), autoimmune primary biliary cholangitis (PBC), and autoimmune hepatitis (AIH). Although liver biopsy is safe and has a very low risk of complications (1/4,000 to 10,000), invasive procedures may be difficult to obtain in a timely fashion or may be unacceptably costly for uninsured patients [Seeff et al. 2010].

An APRI calculator, FIB–4 index calculator, and other online clinical tools are available at Hepatitis C Online. Assays of direct markers of liver fibrosis measure various combinations of liver matrix components in combination with standard biochemical markers. These assays (FibroSure, FibroTest, FibroMeter, FIBROspect II, and HepaScore) appear efficacious in patients with little or no fibrosis and in those with cirrhosis, but, like FIB–4 and APRI, they have limited ability to discriminate between intermediate stages of fibrosis [Castera et al. 2014; Patel and Shackel 2014; Schiavon et al. 2014]. These tests will provide an indication of disease progression over time and can be helpful in counseling patients who are considering treatment [Poynard et al. 2014].
Vibration-controlled transient elastography (VCTE) measures shear wave velocity (expressed in kilopascals) and assesses a larger volume of liver parenchyma than liver biopsy. VCTE is most efficacious in F0–1 and F4 fibrosis but may be difficult to interpret in patients with F2 and F3 disease [Castera et al. 2014; Schiavon et al. 2014; Verveer et al. 2012; Tapper et al. 2015]. Although VCTE is FDA-approved, it is not widely available. Other technologies, such as acoustic radiation force imaging, portal venous transit time, and MRI elastography, show promise for possible future use; these procedures are not recommended at this time because of their lack of sensitivity and specificity in early fibrosis, high cost, and limited availability [EASL 2015; Bohte et al. 2014].

<table>
<thead>
<tr>
<th>Table 3. Methods for Staging Fibrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
</tr>
<tr>
<td>Indirect serum markers</td>
</tr>
<tr>
<td>Direct markers</td>
</tr>
<tr>
<td>VCTE</td>
</tr>
<tr>
<td>Liver biopsy</td>
</tr>
</tbody>
</table>

*See Hepatitis C Online for the following: APRI Calculator and FIB-4 Calculator

References


Poynard T, Vergniol J, Ngo Y, et al. Staging chronic hepatitis C in seven categories using fibrosis biomarker (FibroTest) and transient elastography (FibroScan(R)). *J Hepatol* 2014;60(4):706-14. [PMID: 24291240]


Cirrhosis Evaluation
Hepatitis C Virus Infection Guideline Committee, December 2017

RECOMMENDATIONS

▪ Clinicians should refer all patients with HCV-related cirrhosis for an upper endoscopy to screen for the presence of esophageal varices. (A3)
▪ Clinicians should screen for hepatocellular carcinoma (HCC) with ultrasound, computerized axial tomography (CT), or magnetic resonance imaging (MRI) every 6 months in patients with HCV-related bridging fibrosis or cirrhosis. (A3)

HCV treatment and the achievement of a sustained viral response (SVR) in patients with advanced liver disease dramatically decrease hepatic decompensation events, HCC, and liver–related mortality [AASLD/IDSA HCV Guidance Panel 2015]. To classify the severity of cirrhosis, the Model for End–Stage Liver Disease score (MELD calculator) or the Child–Turcotte–Pugh (CTP) score (Table 4, below) may be used.

Table 4. Calculating the Child–Turcotte–Pugh (CTP) Score for Severity of Cirrhosis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1 point*</th>
<th>2 points*</th>
<th>3 points*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encephalopathy</td>
<td>None</td>
<td>Stage 1 to 2 (or precipitant–induced)</td>
<td>Stage 3 to 4 (or chronic)</td>
</tr>
<tr>
<td>Ascites</td>
<td>None</td>
<td>Mild/moderate (diuretic–responsive)</td>
<td>Severe (diuretic–refractory)</td>
</tr>
<tr>
<td>Bilirubin (mg/dL)</td>
<td>&lt;2.0</td>
<td>2.0 to 3.0</td>
<td>&gt;3.0</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>&gt;3.5</td>
<td>2.8 to 3.5</td>
<td>&lt;2.8</td>
</tr>
<tr>
<td>Prothrombin time (sec prolonged) or INR</td>
<td>&lt;4.0</td>
<td>4.0 to 6.0</td>
<td>&gt;6.0</td>
</tr>
<tr>
<td></td>
<td>&lt;1.7</td>
<td>1.7 to 2.3</td>
<td>&gt;2.3</td>
</tr>
</tbody>
</table>

*CPT score is obtained by adding the score for each parameter. CTP class:
A = 5 to 6 points (compensated, least severe liver disease)
B = 7 to 9 points (decompensated, moderately severe liver disease)
C = 10 to 15 points (decompensated, most severe liver disease)


Assessment for decompensation in patients with cirrhosis can be accomplished through medical history-taking and initial laboratory testing (see Table 5, Evaluation and Follow–Up Screening for Patients with Cirrhosis, below). Decompensation is defined as a MELD score of >15 or the presence of ascites, hepatic encephalopathy, portal hypertensive bleeding, HCC, intractable pruritus, hepatopulmonary syndrome, coagulopathy, or portopulmonary hypertension [Fox and Brown 2012]. Because of the clinical complexity of the condition, patients with a history or presence of decompensated cirrhosis should be referred to a liver disease specialist.

All patients with cirrhosis should undergo an upper endoscopy to screen for the presence of esophageal varices. Patients with HCV–related bridging fibrosis or cirrhosis are at increased risk of developing primary HCC and should undergo surveillance with an ultrasound every 6 months [Bruix and Sherman 2011; Shoreibah et al. 2014]. Alpha–fetoprotein (AFP) determination lacks adequate sensitivity and specificity for effective use in surveillance.
and diagnosis of HCC. Elevated AFP levels may be seen in HCV infection in the absence of HCC [El-Serag and Mason 1999; EASL 2015].

For additional risk stratification and diagnosis information, see American Association of the Study of Liver Diseases (AASLD): Practice Guidance on Portal Hypertensive Bleeding in Cirrhosis [Garcia-Tsao et al. 2017].

### Table 5. Evaluation and Follow-Up Screening for Patients with Cirrhosis

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess for decompensation; refer to a liver disease</td>
<td>• Decompensation is defined as the presence (or history) of 1 of the following:</td>
</tr>
<tr>
<td>specialist if history of decompensation or Child's</td>
<td>• MELD score of &gt;15</td>
</tr>
<tr>
<td>class B or C</td>
<td>• Ascites</td>
</tr>
<tr>
<td></td>
<td>• Hepatic encephalopathy</td>
</tr>
<tr>
<td></td>
<td>• Portal hypertensive bleeding</td>
</tr>
<tr>
<td></td>
<td>• HCC</td>
</tr>
<tr>
<td></td>
<td>• Intractable pruritus</td>
</tr>
<tr>
<td></td>
<td>• Hepatopulmonary syndrome</td>
</tr>
<tr>
<td></td>
<td>• Portopulmonary hypertension</td>
</tr>
<tr>
<td>Abdominal ultrasound to screen for HCC</td>
<td>• Ongoing HCC surveillance should be performed for patients with bridging fibrosis or cirrhosis according to standard guidelines every 6–12 months</td>
</tr>
<tr>
<td></td>
<td>• See AASLD Practice Guideline: Management of Hepatocellular Carcinoma: An Update [Bruix and Sherman 2011]</td>
</tr>
<tr>
<td>Upper endoscopy</td>
<td>• Screen for varices</td>
</tr>
</tbody>
</table>

### References


Baseline Laboratory Testing

Hepatitis C Virus Infection Guideline Committee, updated July 2018

Baseline laboratory testing essential to pre-HCV treatment is listed in Table 6, below.

<table>
<thead>
<tr>
<th>Test</th>
<th>Clinical Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCV RNA quantification</td>
<td>• HCV RNA test confirms active HCV infection and determine HCV viral load</td>
</tr>
<tr>
<td>Genotype/subtype</td>
<td>• Genotype and subtype guide choice of regimen</td>
</tr>
</tbody>
</table>
| Complete blood count (CBC)    | • Low platelets (<140,000 platelets/µL) suggest cirrhosis and portal hypertension [Ebell 2003; Kaul and Munoz 2003]  
• Anemia may necessitate choice of a regimen that does not contain ribavirin (RBV) |
| Serum electrolytes with creatinine | • Marked electrolyte abnormalities may suggest decompensated cirrhosis (e.g., hyponatremia)  
• Renal function will influence choice of regimen                                      |
| Hepatic function panel        | • Elevated direct bilirubin suggests decompensated cirrhosis                                   |
|                               | • Markedly elevated transaminases may suggest comorbidities                                     |
| International normalized ratio (INR) | • Elevated INR suggests decompensated cirrhosis                                                |
| Pregnancy test for all women of childbearing potential | • If pregnant, suggest treatment deferral                                                      |
| Hepatitis A virus (HAV) antibodies | • Obtain HAV antibody (IgG or total) and administer the full HAV vaccine series in patients not immune to HAV |
| Hepatitis B virus (HBV) antibodies | • Obtain HBsAg, anti–HBs, and anti–Hbc (total) and recommend administration of the HBV vaccine series (0, 1, and 6 months) for HBV-susceptible patients (negative for all serologies)  
• In patients with positive HBsAg, perform HBV DNA testing to assess for active HBV infection  
• If HBV DNA is detectable, care providers new to HCV treatment should consult a liver disease specialist regarding treatment for HBV and HCV |
| HIV test if status is unknown | • If HIV infection is confirmed, offer patient antiretroviral therapy  
• See NYSDOH AI guideline When to Initiate ART  
• See Treatment for Patients with HIV/HCV Coinfection in this guideline |
| Urinalysis                    | • Protein may suggest extrahepatic manifestation of HCV                                          |
| Fibrosis serum markers        | • If not previously evaluated by biopsy or FibroScan                                             |

References


# Cardiac, Renal, HAV/HBV, Pregnancy, and Metabolic Status

Hepatitis C Virus Infection Guideline Committee, December 2017

<table>
<thead>
<tr>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
</table>

**Cardiovascular Status**

- For individuals with chronic HCV infection who are aged >50 years, clinicians should perform cardiovascular risk assessment before initiation of treatment with ribavirin (RBV). (A2)

**Renal Status**

- Clinicians should assess creatinine clearance in all patients with HCV infection. (A1)
- Clinicians new to HCV treatment should consult a liver disease specialist when treating patients with severe renal impairment (creatinine clearance <30 mL/min). (A3)

**Hepatitis A (HAV) and/or Hepatitis B (HBV) Immunity Status**

- Clinicians should obtain HAV antibody (IgG or total) and administer the full HAV vaccine series in patients who are not immune to HAV. (A3)
- Clinicians should obtain HBV surface antigen (HBsAg), anti-hepatitis B surface (HBs), and anti-hepatitis B core antigen (HBc), total, and recommend administration of the anti-hepatitis B virus (HBV) vaccine series (0, 1, and 6 months) for HBV-susceptible patients (negative for all serologies). (A3)
  - In patients with positive HBsAg, clinicians should perform HBV DNA testing to assess for active HBV infection (A1)
  - For recommendations for patients with coinfection, see NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Treatment of Patients with HIV/HCV Coinfection > Assessment of HBV Infection in Patients with HIV
- If HBV DNA is detectable, clinicians new to HCV treatment should consult a clinician experienced in the management of both HBV and HCV (A1)

**Pregnancy Status and Contraception**

- Clinicians should perform a pregnancy test in all women of childbearing potential before initiation of HCV treatment and defer HCV treatment in pregnant women. (A2)
- Before initiating ribavirin (RBV), clinicians should (A2):
  - Confirm a negative pregnancy test
  - Advise patients to use 2 methods of birth control to avoid pregnancy during therapy and for 6 months after completion of therapy
  - Counsel female and male patients on effective contraceptive use

**Contraindication:** Clinicians should not use RBV in treatment of the following patients:

- Female or male patients planning conception within 6 months of the last dose of RBV (A2)
- Male patients who have pregnant partners (A2)

**Contraindication:** Clinicians should not use paritaprevir/ritonavir/ombitasvir/dasabuvir (PrOD) in treatment of women taking ethinyl estradiol–containing contraceptives. (A2)

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**Cardiovascular Status**

Cardiovascular disease and congestive heart failure may be worsened by possible anemia associated with the use of RBV–containing regimens. Individuals taking RBV–containing regimens may be at risk of anemia and subsequent high-output failure, as well as decreased oxygen–carrying capacity and subsequent ischemia [Kaul and Munoz 2000]. In patients being considered for RBV–containing regimens, it is important to assess for underlying cardiac disease and, if unstable cardiac disease is present, stabilize these patients before initiation of RBV.

Drug–drug interactions between DAA medications and cardiovascular medications have been reported and may require adjustments or changes before initiation of therapy (see Drug–Drug Interactions in this guideline).
Renal Status
A patient's renal status will influence the choice of DAA regimen. Evaluation for renal disease includes assessing HCV-related causes of kidney disease such as membranoproliferative glomerulonephritis and membranous glomerulonephritis, even if patients have other comorbidities also associated with kidney disease, such as diabetes and hypertension.

HAV and/or HBV Immunity Status
Completion of HAV and HBV vaccination is not a pretreatment mandate and is appropriate during or after treatment for chronic HCV infection. Coinfection with HCV and either HAV or HBV may result in additional liver inflammation and pathology, and vaccination against HAV and HBV is important for patients with HCV infection to prevent acute decompensation and the sequelae of chronic superinfection by HBV [Lau and Hewlett 2005]. Approximately 40% to 50% of patients with HCV have no documented immunity against HAV or HBV [Henkle et al. 2015].

If a patient is susceptible to both HAV and HBV infection, the combined vaccination series should be initiated. The laboratory assessment and vaccination (as appropriate) for HAV and HBV should be performed as soon as possible, but completion of the vaccination series is not necessary before initiation of HCV treatment. For more information, see: Hepatitis C Online.

Vaccination of patients with a reactive anti-HBc and nonreactive HBsAg and anti-HBs (i.e., isolated anti-HBc) is controversial because results are subject to several interpretations. In patients from regions in which HBV infection is highly endemic or in patients with risk factors for acquiring HBV, a reactive anti-HBc result may represent acute or chronic active HBV or serologic clearance of anti-HBs after a prior infection. In patients who have no risk factors or who are from regions in which HBV infection rates are low, a reactive anti-HBc result may represent a false positive result. In patients with isolated anti-HBc, HBV DNA testing to assess for active HBV infection is recommended, with subsequent vaccination if results are negative.

HBV reactivation and HBV-related hepatic flares, sometimes fulminant, have been reported both during and after DAA therapy in patients who were not receiving concurrent HBV treatment [Hayashi et al. 2016; Takayama et al. 2016; Ende et al. 2015; Collins et al. 2015; De Monte et al. 2016; Sulkowski et al. 2016; Wang et al. 2017]. Studies have demonstrated that HCV has a suppressive effect on HBV replication, and previous interferon-based treatments were active against both viruses [Chen et al. 2003; Chu et al. 1998; Liu and Hou 2006; Shih et al. 1993]. However, unlike interferon, DAAs are not active against HBV, and when HCV is eradicated, HBV may be able to replicate. For more information about the risk of HBV reactivation, see: U.S. Food and Drug Administration (FDA) Drug Safety Warning.

Pregnancy Status and Contraception
The data on use of DAA therapy in pregnancy is limited, and treatment of pregnant women is currently not recommended. For women who are considering pregnancy, it is important to discuss the risks and benefits of deferring treatment until after pregnancy.

For all women and men planning conception within 6 months of treatment, use of RBV is contraindicated due to the teratogenic effects of the drug [FDA 2011]. Before prescribing an RBV-containing regimen for a woman of childbearing potential, a negative pregnancy test is required immediately before initiation of therapy and 2 forms of contraception or abstinence are advised during therapy and for 6 months after. Extreme care must be taken to avoid pregnancy during therapy and for 6 months after completion of therapy in female patients and in female partners of male patients who are taking RBV.
The paritaprevir/ritonavir/ombitasvir/dasabuvir regimen is contraindicated in women taking ethinyl estradiol-containing medication/contraceptives [FDA 2017]. Among patients taking ombitasvir/paritaprevir/ritonavir plus dasabuvir, the incidence of clinically relevant alanine transaminase (ALT) elevations was 25% (4/16) among women taking a concomitant ethinyl estradiol-containing medication compared with 3% among women using estrogens other than ethinyl estradiol, such as estradiol and conjugated estrogens used in hormone replacement therapy (2/59). This result suggests that the need for use of alternative methods of contraception (progestin–only contraception or non–hormonal methods) during treatment with this regimen [FDA 2017].

**KEY POINTS**

- RBV is contraindicated in female and male patients planning conception within 6 months of treatment [FDA 2011].
- To use an RBV-containing regimen in women of childbearing potential or in the male sex partners of these women, extreme care must be taken to avoid pregnancy during therapy and for 6 months after completion of therapy:
  - A negative pregnancy test is required immediately before initiation of therapy; and
  - Two forms of contraception or abstinence are advised during, and for 6 months after, therapy.

**Metabolic Status**

Obesity does not affect treatment of HCV with DAAs. Among individuals with HCV infection, both obesity and hepatic steatosis have been associated with progression of fibrosis and increased risk of advanced liver disease [Charlton et al. 2006; Bressler et al. 2003; Dyal et al. 2015; Goossens and Negro 2014].


**References**


Chu CM, Yeh CT, Liaw YF. Low–level viremia and intracellular expression of hepatitis B surface antigen (HBsAg) in HBsAg carriers with concurrent hepatitis C virus infection. *J Clin Microbiol* 1998;36(7):2084–6. [PMID: 9650968]


Treatment Options

Hepatitis C Virus Infection Guideline Committee, December 2017

The treatment of chronic HCV infection has evolved significantly in recent years following advances in the understanding of the HCV genome and HCV proteins [Pockros 2017]. As a result, new, highly effective therapies are available for patients who are treatment-naïve and -experienced, who do and do not have cirrhosis, and who have any HCV genotype (see Box 2, below). Before the availability of these new therapies, many patients and practitioners had been reluctant to initiate therapy for chronic HCV infection due to suboptimal sustained virologic response (SVR) rates and significant rates of adverse events. These concerns are no longer applicable with direct-acting antivirals (DAAs).

DAAs are molecules that work at different stages of the HCV lifecycle, targeting and inhibiting specific nonstructural proteins of HCV to disrupt viral replication and infection [Pockros 2017]. The four classes of DAAs are defined by their mechanism of action and therapeutic target.

**Box 2. DAAs for Treatment of HCV**

- **Protease inhibitors [−previrs]:** Glecaprevir, grazoprevir, paritaprevir, simeprevir, voxilaprevir, telaprevir, boceprevir
- **NS5a inhibitors [−asvir]:** Daclatasvir, elbasvir, ledipasvir, ombitasvir, velpatasvir, pibrentasvir
- **NS5B nucleoside polymerase inhibitors [−buvirs]:** Sofosbuvir
- **NS5V non-nucleoside polymerase inhibitors [−buvirs]:** Dasabuvir

Goals of Treatment and DAA Regimen Choice

The goal of treatment in patients with chronic HCV infection is to attain a virologic cure, as evidenced by an SVR, in order to reduce all-cause mortality and liver-related complications, including end-stage liver disease, hepatocellular carcinoma (HCC), and the morbidity and mortality associated with the extrahepatic manifestation of chronic HCV infection. With the significant advances in treatment, all patients with chronic HCV infection, regardless of fibrosis stage, are considered candidates for antiviral therapy [Simmons et al. 2015; Smith-Palmer et al. 2015; van der Meer 2012].

This guideline includes recommendations for treating patients with chronic HCV infection, with consideration of individual characteristics, such as viral genotype, presence of cirrhosis, and previous treatment history. There are several options for treatment in each category, and no single regimen in any given category is prioritized or recommended over another. Regimens are listed alphabetically. The choice of treatment is based on specific individual patient factors, such as comorbid medical conditions, potential drug–drug interactions, and cost/coverage.

**KEY POINTS**

- Clinicians can increase their patients’ ability to understand treatment-related information and to participate in decision-making if they communicate with language that is clear, easily understood, jargon-free, and culturally sensitive.
- Patient preferences are central to all treatment decisions.

References


Considerations
Hepatitis C Virus Infection Guideline Committee, updated July 2018

✓ RECOMMENDATIONS

Considerations in HCV Treatment

- Clinicians should assess creatinine clearance before initiating antiviral therapy. (A1)
- Clinicians new to HCV treatment should consult a liver disease specialist when treating patients who:
  - Have severe renal impairment (creatinine clearance <30 mL/min) and/or are undergoing hemodialysis (A3)
  - Require retreatment after treatment failure with any DAA regimen (B3)
    - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Regimens for Retreatment After DAA Failure
- Clinicians should prescribe ribavirin (RBV) with caution for patients with a creatinine clearance <50 mL/min. (A1)
  - If prescribed, a reduced dose of 200 mg per day is required
  - Non-RBV-containing regimens can be prescribed without dose adjustments for patients with a creatinine clearance ≥30 mL/min

Contraindications

- Clinicians should not use RBV in treatment of the following patients:
  - Female or male patients planning conception within 6 months of the last dose of RBV (A2)
  - Male patients who have pregnant partners (A2)
- Clinicians should not use paritaprevir/ritonavir/ombitasvir/dasabuvir (PrOD) in treatment of women who are taking ethinyl estradiol-containing contraceptives. (A2)

KEY POINT

- The most suitable regimen for any individual patient depends on the patient’s preference and the clinician’s assessment of comorbidities, such as chronic kidney disease, potential drug–drug interactions with the patient’s current prescription and over-the-counter medications (see Drug–Drug Interactions in this guideline); medication tolerability and adverse event profile; and duration of treatment. Sex, age, viral load levels, substance use disorders, mental health disorders, pill burden, and HIV coinfection are not considerations in selecting HCV treatment regimens.

Selection of a treatment regimen for patients with chronic HCV infection is based on viral genotype, the presence of cirrhosis, treatment history (treatment-naive vs –experienced), the potential for drug–drug interactions, and other specific considerations, noted previously, such as the presence of cardiac disease, renal function, and choice of contraception.

KEY POINT

- Cardiac disease and other comorbidities may affect a patient’s ability to tolerate RBV–induced anemia and should be considered before initiating an RBV–containing regimen.

Renal Impairment

For patients with a creatinine clearance <50 mL/min, RBV should be used with caution; if used, a reduced dose of 200 mg per day is recommended [FDA 2011]. Limited evidence is available to support the use of fixed-dose combination ledipasvir/sofosbuvir or sofosbuvir in treating patients with HCV infection and severe renal impairment (creatinine clearance <30 mL/min). Fixed-dose combination paritaprevir/ritonavir/ombitasvir without ribavirin does
not require dose adjustment in severe renal impairment, but data on treatment of patients receiving hemodialysis are limited. The combinations elbasvir/grazoprevir and glecaprevir/pibrentasvir require no dose adjustment for renal impairment, even when used by patients receiving hemodialysis [FDA 2016; Zeuzem et al 2017].

**Resistance Testing**

At present, testing for resistance–associated variants (RAV) is not universally recommended. RAVs are also referred to as resistance analysis populations (RAP) and resistance–associated substitutions (RAS). However, this committee recommends that clinicians test for the presence of NS5A RAVs before starting therapy with elbasvir/grazoprevir in all patients with HCV genotype 1a infection (see Recommended DAA Regimens in this guideline) [Zeuzem et al 2017]. The presence of one or more HCV NS5A RAVs at position M28, Q30, L31, or Y93 was associated with a reduced efficacy of elbasvir/grazoprevir given for 12 weeks, regardless of prior treatment history or the presence or absence of cirrhosis [FDA 2016]. Sixteen weeks of elbasvir/grazoprevir plus weight–based RBV was associated with an SVR rate of 100% in genotype 1a patients with NS5A RAVs [Zeuzem et al 2017]. RAV testing is also performed in persons in whom DAA regimens containing an NS5A or NS5B inhibitor have failed and are being considered for retreatment.

For more information on HCV resistance, please see the AASLD/IDSA HCV Resistance Primer.

**Pregnancy and Contraception**

For all women and men planning conception within 6 months of treatment, use of RBV is contraindicated due to the teratogenic effects of the drug [FDA 2011]. Before prescribing an RBV–containing regimen for a woman of childbearing potential, a negative pregnancy test is required immediately before initiation of therapy and 2 forms of contraception or abstinence are advised during therapy and for 6 months after. Extreme care must be taken to avoid pregnancy during therapy and for 6 months after completion of therapy in female patients and in female partners of male patients who are taking RBV.

The paritaprevir/ritonavir/ombitasvir/dasabuvir regimen is contraindicated in women taking ethinyl estradiol–containing medication/contraceptives [FDA 2017]. Among patients taking ombitasvir/paritaprevir/ritonavir plus dasabuvir, the incidence of clinically relevant alanine aminotransferase (ALT) elevations was 25% (4/16) among women taking a concomitant ethinyl estradiol–containing medication compared with 3% among women using estrogens other than ethinyl estradiol, such as estradiol and conjugated estrogens used in hormone replacement therapy (2/59). This result suggests that alternative methods of contraception (progestin–only contraception or non–hormonal methods) are needed during treatment with this regimen [FDA 2017].

**References**


Recommended DAA Regimens

Hepatitis C Virus Infection Guideline Committee, updated July 2018

All regimens listed in this guideline were available as of December 2017.

These recommendations on treatment of chronic HCV were developed by the NYSDOH AI HCV Guideline Committee to guide primary care providers and other clinicians in NYS in treating patients with chronic HCV infection.

**HIV/HCV coinfection:** Treatment of chronic HCV infection in patients with HIV requires attention to drug–drug interactions between DAAs and antiretrovirals (ARVs) and to a few other HIV-specific treatment issues (see Treatment of Patients with HIV/HCV Coinfection in this guideline). Otherwise, clinicians should follow the recommendations below for treatment of patients with HCV monoinfection and consult a liver disease specialist and an experienced HIV care provider as needed.

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### KEY POINTS: CHOOSING AN ANTI-HCV TREATMENT REGIMEN

- Treatment regimen recommendations are organized according to HCV genotype and subtype, the presence or absence of compensated cirrhosis, and HCV treatment history.
- The recommended regimens within each list are in alphabetical order, not in order of preference.
- No single regimen is recommended over another within each list of options; data on direct comparisons of treatment regimens have not been published.
- The choice of regimen should be based on individual pretreatment assessment findings, the general considerations detailed above, and insurance coverage.
- The regimens recommended for retreatment are for patients who have been treated previously with DAAs or pegylated interferon (PEG–IFN) plus ribavirin (RBV).

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Recommended oral direct-acting antiviral drugs and drug regimens are listed in Table 7, below. All regimens listed in drug regimen tables for all HCV genotypes refer to oral medications.

### Table 7. Recommended Oral DAAs and Drug Regimens

<table>
<thead>
<tr>
<th>Drug/Combination</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbasvir/grazoprevir*</td>
<td>Zepatier</td>
</tr>
<tr>
<td>Glecaprevir/pibrentasvir</td>
<td>Mavyret</td>
</tr>
<tr>
<td>Ledipasvir/sofosbuvir*</td>
<td>Harvoni</td>
</tr>
<tr>
<td>Paritaprevir/ritonavir/ombitasvir</td>
<td>Technivie</td>
</tr>
<tr>
<td>Paritaprevir/ritonavir/ombitasvir/</td>
<td>Viekira XR</td>
</tr>
<tr>
<td>Sofosbuvir</td>
<td>Sovaldi</td>
</tr>
<tr>
<td>Sofosbuvir/velpatasvir*</td>
<td>Epclusa</td>
</tr>
<tr>
<td>Sofosbuvir/velpatasvir/voxilaprevir</td>
<td>Vosevi</td>
</tr>
</tbody>
</table>

*These drugs are co-formulated (indicated by the “/”).
# Genotype 1a

Hepatitis C Virus Infection Guideline Committee, December 2017

## RECOMMENDATIONS

- Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotype 1a listed in tables 8 through 11, below.
- Clinicians should test for the presence of NS5A resistance-associated variants (RAVs) before starting therapy with elbasvir/grazoprevir in all patients with HCV genotype 1a infection. (AII)
- If a regimen with weight-based ribavirin (RBV) is chosen, clinicians should dose as follows: (AI)
  - <75 kg: RBV 400 mg once daily + 600 mg once daily (total daily dose: 1000 mg)
  - ≥75 kg: RBV 600 mg twice daily (total daily dose: 1200 mg)

### Recommended regimens: The recommendations are organized by previous HCV treatment (treatment-naive or treatment-experienced) and whether or not the patient has compensated cirrhosis. All drugs in the recommended regimens below are oral medications.

### Drug names: Use of a "/" between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

### Rating of regimens: All regimen choices listed below are rated AI (strong recommendation, with high quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints) except where indicated.

### Table 8. Genotype 1a • Treatment-naive • No cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017a] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td>Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily plus weight-based ribavirin twice daily [Feld et al. 2014; Ferenci et al. 2014] (PTV/RTV/OBV/DSV; PrOD; Viekira XR plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015; Lawitz et al. 2015; Sulkowski et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
<tr>
<td><strong>Without baseline NS5A polymorphisms:</strong> Elbasvir 50 mg/grazoprevir 100 mg once daily [Lawitz et al. 2015; Sulkowski et al. 2015; Zeuzem et al. 2015] (ELB/GRZ; Zepatier)</td>
<td>12 weeks</td>
</tr>
<tr>
<td><strong>With baseline NS5A polymorphisms:</strong> Elbasvir 50 mg/grazoprevir 100 mg once daily plus weight-based ribavirin twice daily [FDA 2016] (ELB/GRZ; Zepatier plus RBV; Copegus)</td>
<td>16 weeks</td>
</tr>
<tr>
<td><strong>For patients who are non-black, HIV-uninfected, and have HCV RNA &lt;6 million copies/mL (Rating: AII):</strong> Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Kowdley et al. 2014, 2017; Terrault et al. 2016; FDA 2015] (LED/SOF; Harvoni)</td>
<td>8 weeks</td>
</tr>
<tr>
<td><strong>For patients who are black, HIV-infected, or have HCV RNA ≥6 million copies/mL:</strong> Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Kowdley et al. 2014, 2017; Terrault et al. 2016; FDA 2015] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>
### Table 9. Genotype 1a • Treatment-naive • Compensated cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017a; Gane et al. 2016] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Bourliere et al. 2015; Reddy et al. 2015] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily plus weight-based ribavirin twice daily [FDA 2017b] (PTV/RTV/OBV/DSV; PrOD; Viekira XR plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

**Without baseline NS5A polymorphisms:** Elbasvir 50 mg/grazoprevir 100 mg once daily [Lawitz et al. 2015; Zeuzem et al. 2015] (ELB/GRZ; Zepatier) 12 weeks

**With baseline NS5A polymorphisms:** Elbasvir 50 mg/grazoprevir 100 mg once daily plus weight-based ribavirin twice daily [FDA 2016] (ELB/GRZ; Zepatier plus RBV; Copegus) 16 weeks

### Table 10. Genotype 1a • Prior failure with PEG–IFN* • No cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens for retreatment (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017a] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Afdhal et al. 2014] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily plus weight-based ribavirin twice daily [Zeuzem et al. 2014] (PTV/RTV/OBV/DSV; PrOD; Viekira XR plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

**Without baseline NS5A polymorphisms:** Elbasvir 50 mg/grazoprevir 100 mg once daily [Forns et al. 2015] (ELB/GRZ; Zepatier) 12 weeks

**With baseline NS5A polymorphisms:** Elbasvir 50 mg/grazoprevir 100 mg once daily plus weight-based ribavirin twice daily [Buti et al. 2016] (ELB/GRZ; Zepatier plus RBV; Copegus) 16 weeks

*Pegylated interferon plus ribavirin.
Table 11. Genotype 1a • Prior failure with PEG–IFN plus RBV* • Compensated cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens for retreatment (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017a] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Bourliere et al. 2014, 2015] (LED/SOF; Harvoni)</td>
<td>24 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily plus weight–based ribavirin twice daily [Bourliere et al. 2014, 2015] (LED/SOF; Harvoni plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily plus weight–based ribavirin twice daily [Poordad et al. 2014] (PTV/RTV/OBV/DSV; PrOD; Viekira XR plus RBV; Copegus)</td>
<td>24 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

**Without baseline NS5A polymorphisms:**

Elbasvir 50 mg/grazoprevir 100 mg once daily [Lawitz et al. 2015] (ELB/GRZ; Zepatier) 12 weeks

**With baseline NS5A polymorphisms:**

Elbasvir 50 mg/grazoprevir 100 mg once daily plus weight–based ribavirin twice daily [FDA 2016] (ELB/GRZ; Zepatier plus RBV; Copegus) 16 weeks

*Pegylated interferon plus ribavirin.

References


FDA. Harvoni (ledipasvir and sofosbuvir) tablets, for oral use. 2015 Mar. https://www.accessdata.fda.gov/drugsatfda_docs/label/2015/205834s001lbl.pdf [accessed 2017 Dec 18]


Lawitz E, Gane E, Pearlman B, et al. Efficacy and safety of 12 weeks versus 18 weeks of treatment with grazoprevir (MK-5172) and elbasvir (MK-8742) with or without ribavirin for hepatitis C virus genotype 1 infection in previously untreated patients with cirrhosis and patients with previous null response with or without cirrhosis (C-WORTHY): a randomised, open-label phase 2 trial. *Lancet* 2015;385(9973):1075–86. [PMID: 25467591]


Genotype 1b

Hepatitis C Virus Infection Guideline Committee, December 2017

RECOMMENDATIONS

- Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotype 1b listed in tables 12 through 15, below.
- If a regimen with weight-based ribavirin (RBV) is chosen, clinicians should dose as follows: (AI)
  - <75 kg: RBV 400 mg once daily + 600 mg once daily (total daily dose: 1000 mg)
  - ≥75 kg: RBV 600 mg twice daily (total daily dose: 1200 mg)

Recommended regimens: The recommendations are organized by previous HCV treatment (treatment-naïve or treatment-experienced) and whether or not the patient has compensated cirrhosis. All drugs in the recommended regimens below are oral medications.

Drug names: Use of a “/” between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

Rating of regimens: All regimen choices listed are rated AI (strong recommendation, with high-quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints) except where indicated.

Table 12. Genotype 1b • Treatment-naïve • No cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elbasvir 50 mg/grazoprevir 100 mg once daily [Zeuzem et al. 2015; Lawitz et al. 2015; Sulkowski et al. 2015] (ELB/GRZ; Zepatier)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td>Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily [Feld et al. 2014; Ferenci et al. 2014] (PTV/RTV/OBV/DSV; PrOD; Viekira XR)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

For patients who are non-black, HIV-uninfected, and have HCV RNA <6 million copies/mL (Rating: AII): Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Kowdley et al. 2014, 2017; Terrault et al. 2016; FDA 2015] (LED/SOF; Harvoni) | 8 weeks |

For patients who are black, HIV-infected, or have HCV RNA ≥6 million copies/mL: Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Kowdley et al. 2014, 2017; Terrault et al. 2016; FDA 2015] (LED/SOF; Harvoni) | 12 weeks |
### Table 13. Genotype 1b • Treatment-naive • Compensated cirrhosis

**Choose 1 of the following regimens (AI):** | **Duration**
---|---
Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Bourlier et al. 2015; Reddy et al. 2015] (LED/SOF; Harvoni) | 12 weeks
Elbasvir 50 mg/grazoprevir 100 mg once daily [Zeuzem et al. 2015; Lawitz et al. 2015] (ELB/GRZ; Zepatier) | 12 weeks
Glecaprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017] (GLE/PIB; Mavyret) | 12 weeks
Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily [Feld et al. 2014] (PTV/RTV/OBV/DSV; PrOD; Viekira XR) | 12 weeks
Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa) | 12 weeks

### Table 14. Genotype 1b • Prior failure with PEG–IFN plus RBV* • No cirrhosis

**Choose 1 of the following regimens for retreatment (AI):** | **Duration**
---|---
Elbasvir 50 mg/grazoprevir 100 mg once daily [Lawitz et al. 2015] (ELB/GRZ; Zepatier) | 12 weeks
Glecaprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Poordad et al. 2017] (GLE/PIB; Mavyret) | 8 weeks
Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Lawitz et al. 2014; Afdhal et al. 2014] (LED/SOF; Harvoni) | 12 weeks
Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily [Andreone et al. 2014] (PTV/RTV/OBV/DSV; PrOD; Viekira XR) | 12 weeks
Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa) | 12 weeks

*Pegylated interferon plus ribavirin.

### Table 15. Genotype 1b • Prior failure with PEG–IFN plus RBV* • Compensated cirrhosis

**Choose 1 of the following regimens for retreatment (AI):** | **Duration**
---|---
Elbasvir 50 mg/grazoprevir 100 mg once daily [Lawitz et al. 2015] (ELB/GRZ; Zepatier) | 12 weeks
Glecaprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017] (GLE/PIB; Mavyret) | 12 weeks
Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Bourliere et al. 2014, 2015] (LED/SOF; Harvoni) | 24 weeks
Ledipasvir 90 mg/sofosbuvir 400 mg once daily plus weight-based ribavirin twice daily [Bourliere et al. 2014, 2015] (LED/SOF; Harvoni plus RBV; Copegus) | 12 weeks
Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg/dasabuvir 600 mg once daily [Poordad et al. 2014] (PTV/RTV/OBV/DSV; PrOD; Viekira XR) | 12 weeks
Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa) | 12 weeks

*Pegylated interferon plus ribavirin.*
References


FDA. Harvoni (ledipasvir and sofosbuvir) tablets, for oral use. 2015 Mar. https://www.accessdata.fda.gov/ drugsatfda_docs/label/2015/205834s001lbl.pdf [accessed 2017 Dec 18]


Genotype 2
Hepatitis C Virus Infection Guideline Committee, December 2017

✓ RECOMMENDATION

- Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotype 2 listed in tables 16 through 18, below.

Recommended regimens: The recommendations are organized by previous HCV treatment (treatment-naïve or treatment-experienced) and whether or not the patient has compensated cirrhosis. All drugs in the recommended regimens below are oral medications.

Drug names: Use of a “/” between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

Rating of regimens: All regimen choices listed below are rated AI (strong recommendation, with high quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints).

Note: The daclatasvir plus sofosbuvir regimen is not approved by the U.S. Food and Drug Administration for treatment of patients with genotype 2 HCV infection as of March 31, 2017; however, published evidence [Kwo et al. 2017] supports use of this combination, and it is commonly prescribed.

Table 16. Genotype 2 • Treatment-naïve • No cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Foster et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>
References
Genotype 3
Hepatitis C Virus Infection Guideline Committee, December 2017

✓ RECOMMENDATION

Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotype 3 listed in tables 19 through 22, below.

Recommended regimens: The recommendations are organized by previous HCV treatment (treatment-naïve or treatment-experienced) and whether or not the patient has compensated cirrhosis. All drugs in the recommended regimens below are oral medications.

Drug names: Use of a “/” between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

Rating of regimens: All regimen choices listed below are rated AI (strong recommendation, with high quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints).

Sustained virologic response (SVR) rate: SVR rates are listed from studies of patients with HCV genotype 3 (reference numbers are cited in each table). These data have been included only for genotype 3 because, to date, achievement of an SVR in these patients, especially those with cirrhosis, has proven to be more difficult than it is in patients with other HCV genotypes.

<table>
<thead>
<tr>
<th>Table 19. Genotype 3 • Treatment-naïve • No cirrhosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose 1 of the following regimens (AI):</td>
</tr>
<tr>
<td>Duration</td>
</tr>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily (SVR, 83% to 94%) [FDA 2017;1,2] (GLE/PIB; Mavyret)</td>
</tr>
<tr>
<td>Sofosbuvir 400/velpatasvir 100 mg once daily (SVR, 98%) [Foster et al 2015a] (SOF/VEL; Epclusa)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 20. Genotype 3 • Treatment-naïve • Compensated cirrhosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose 1 of the following regimens (AI):</td>
</tr>
<tr>
<td>Duration</td>
</tr>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily (SVR, 98%) [FDA 2017] (GLE/PIB; Mavyret)</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily (SVR, 93%) [Foster et al 2015a] (SOF/VEL; Epclusa)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 21. Genotype 3 • Prior failure with Peg-IFN plus RBV* • No cirrhosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose 1 of the following regimens for retreatment (AI):</td>
</tr>
<tr>
<td>Duration</td>
</tr>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily (SVR, 98%) [FDA 2017] (GLE/PIB; Mavyret)</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily (SVR, 91%) [Foster et al 2015a] (SOF/VEL; Epclusa)</td>
</tr>
</tbody>
</table>

*Pegylated interferon plus ribavirin.
Table 22. Genotype 3 • Prior failure with PEG-IFN plus RBV* • Compensated cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens for retreatment (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily (SVR, 98%) [FDA 2017] (GLE/PIB; Mavyret)</td>
<td>16 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily (SVR, 89%) [Foster et al. 2015b] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

*Pegylated interferon plus ribavirin.

References


Genotype 4
Hepatitis C Virus Infection Guideline Committee, December 2017

**RECOMMENDATION**

- Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotype 4 listed in tables 23 and 24, below.
- If a regimen with weight-based ribavirin (RBV) is chosen, clinicians should dose as follows: (AI)
  - <75 kg: RBV 400 mg once daily + 600 mg once daily (total daily dose: 1000 mg)
  - ≥75 kg: RBV 600 mg twice daily (total daily dose: 1200 mg)

**Recommended regimens:** The recommendations are organized by previous HCV treatment (treatment-naïve or treatment-experienced) and whether or not the patient has compensated cirrhosis. All drugs in the recommended regimens below are oral medications.

**Drug names:** Use of a “/” between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

**Rating of regimens:** All regimen choices listed below are rated AI (strong recommendation, with high quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints).

| Table 23. Genotype 4 • Treatment-naïve • No cirrhosis OR compensated cirrhosis |
|----------------------------------|------------------|
| Choose 1 of the following regimens (AI): | Duration |
| Elbasvir 50 mg/grazoprevir 100 mg once daily [Zeuzem et al. 2015] (ELB/GRZ; Zepatier) | 12 weeks |
| **No cirrhosis:** Gileadprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret) | 8 weeks |
| **Compensated cirrhosis:** Gileadprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret) | 12 weeks |
| Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Kohli et al. 2015; Abergel et al. 2016] (LED/SOF; Harvoni) | 12 weeks |
| Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg once daily plus weight-based ribavirin twice daily [Hezode et al. 2015] (PTV/RTV/OBV; Technivie plus RBV; Copegus) | 12 weeks |
| Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa) | 12 weeks |
Table 24. Genotype 4 • Prior failure with Peg-IFN plus RBV* • No cirrhosis OR compensated cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens for retreatment (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No cirrhosis:</strong> Elbasvir 50 mg/grazoprevir 100 mg once daily plus weight-based ribavirin twice daily [Zeuzem et al. 2015; FDA 2016] (ELB/GRZ; Zepatier plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td><strong>Compensated cirrhosis:</strong> Elbasvir 50 mg/grazoprevir 100 mg once daily plus weight-based ribavirin twice daily [Zeuzem et al. 2015; FDA 2016] (ELB/GRZ; Zepatier plus RBV; Copegus)</td>
<td>16 weeks</td>
</tr>
<tr>
<td><strong>No cirrhosis:</strong> Glecaprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td><strong>Compensated cirrhosis:</strong> Glecaprevir 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Kohli et al. 2015] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Paritaprevir 150 mg/ritonavir 100 mg/ombitasvir 25 mg once daily plus weight-based ribavirin twice daily [Hezode et al. 2015] (PTV/RTV/OBV; Technivie plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

*Pegylated interferon plus ribavirin.

References


Genotype 5
Hepatitis C Virus Infection Guideline Committee, December 2017

✓ RECOMMENDATION

- Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotype 5 listed in tables 25 and 26, below.

Recommended regimens: The recommendations are organized by previous HCV treatment (treatment-naïve or treatment-experienced) and whether or not the patient has compensated cirrhosis. All drugs in the recommended regimens below are oral medications.

Drug names: Use of a “/” between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

Rating of regimens: All regimen choices listed below are rated AI (strong recommendation, with high quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints).

<p>| Table 25. Genotype 5 • Treatment-naive • No cirrhosis OR compensated cirrhosis |</p>
<table>
<thead>
<tr>
<th>Choose 1 of the following regimens (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No cirrhosis:</strong> Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td><strong>Compensated cirrhosis:</strong> Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Abergel et al. 2016] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

<p>| Table 26. Genotype 5 • Prior failure with PEG–IFN plus RBV* • No cirrhosis OR compensated cirrhosis |</p>
<table>
<thead>
<tr>
<th>Choose 1 of the following regimens for retreatment (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No cirrhosis:</strong> Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td><strong>Compensated cirrhosis:</strong> Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Kwo et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Abergel et al. 2016] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

*Pegylated interferon plus ribavirin.
References


Genotype 6
Hepatitis C Virus Infection Guideline Committee, December 2017

RECOMMENDATION

- Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotype 6 listed in tables 27 and 28, below.

Recommended regimens: The recommendations are organized by previous HCV treatment (treatment-naïve or treatment-experienced) and whether or not the patient has compensated cirrhosis. All drugs in the recommended regimens below are oral medications.

Drug names: Use of a “/” between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

Rating of regimens: All regimen choices listed below are rated AI (strong recommendation, with high quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints).

Table 27. Genotype 6 • Treatment-naïve • No cirrhosis OR compensated cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No cirrhosis</strong>: Gilead 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td><strong>Compensated cirrhosis</strong>: Gilead 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Gane et al. 2015] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

Table 28. Genotype 6 • Prior failure with PEG–IFN plus RBV* • No cirrhosis OR compensated cirrhosis

<table>
<thead>
<tr>
<th>Choose 1 of the following regimens for retreatment (AI):</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No cirrhosis</strong>: Gilead 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret)</td>
<td>8 weeks</td>
</tr>
<tr>
<td><strong>Compensated cirrhosis</strong>: Gilead 300 mg/pibrentasvir 120 mg once daily [FDA 2017; Kwo et al. 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Gane et al. 2015] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Feld et al. 2015] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Pegylated interferon plus ribavirin.</td>
<td></td>
</tr>
</tbody>
</table>
References


Regimens for Retreatment After DAA Failure
Hepatitis C Virus Infection Guideline Committee, updated July 2018

RECOMMENDATIONS

- Clinicians new to HCV treatment should consult a liver disease specialist when retreating a patient who has failed treatment with any DAA regimen. (B3) Failure is defined as detectable HCV RNA 12 weeks after the conclusion of HCV treatment.
- If a regimen with weight-based ribavirin (RBV) is chosen, clinicians should dose as follows: (A1)
  - <75 kg: RBV 400 mg once daily + 600 mg once daily (total daily dose: 1000 mg)
  - ≥75 kg: RBV 600 mg twice daily (total daily dose: 1200 mg)

Treatment regimens are now approved and available for patients with HCV genotypes 1, 2, 3, 4, 5, and 6 who failed previous DAA treatment (see Tables 29 to 32). Recommendations for treatment dose and duration are based on previous exposure to either NS3/4A protease inhibitors or NS5A polymerase inhibitors. None of the regimens approved for retreatment after DAA treatment failure requires resistance testing or the addition of ribavirin.

Regimens for Use After DAA Treatment Failure

All drugs in the recommended regimens below are oral medications. In addition to the patient's previous treatment regimen(s), the presence of cirrhosis and patient preferences influence the choice of regimen.

Drug names: Use of a “/” between two drug names indicates a co-formulated tablet. Use of the word “plus” indicates two separate drugs.

Rating of regimens: All regimen choices listed below are rated AI (strong recommendation, with high quality evidence from at least 1 randomized trial with clinical outcomes and/or validated laboratory endpoints).

<table>
<thead>
<tr>
<th>Table 29. Prior failure with an NS5A inhibitor*–containing regimen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Choose 1 of the following regimens for retreatment (AI):</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Cirrhosis Status</th>
<th>Regimens</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No cirrhosis; compensated cirrhosis</td>
<td>No previous treatment with NS3/4A protease inhibitors*: Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Poordad et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>16 weeks</td>
</tr>
<tr>
<td>3</td>
<td>Compensated cirrhosis</td>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg/voxilaprevir 100 mg once daily plus weight-based ribavirin twice daily [Bourliere et al. 2017] (SOF/VEL/VOX; Vosevi plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>1,2,3,4,5,6</td>
<td>No cirrhosis; compensated cirrhosis</td>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg/voxilaprevir 100 mg once daily [Bourliere et al. 2017; Gane et al. 2016] (SOF/VEL/VOX; Vosevi)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

*NS5A polymerase inhibitors: daclatasvir, elbasvir, ledipasvir, ombitasvir, and velpatasvir

§ NS3/4A protease inhibitors: grazoprevir, paritaprevir, and voxilaprevir
Table 30. Prior failure with an NS3/4A inhibitor*-containing regimen that did not contain an NS5A inhibitor§ • No cirrhosis OR compensated cirrhosis

Choose 1 of the following regimens for retreatment (AI):

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Cirrhosis Status</th>
<th>Regimens</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No cirrhosis; compensated</td>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Poordad et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td></td>
<td>compensated cirrhosis</td>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg once daily [Bourliere et al. 2017] (SOF/VEL; Epclusa)</td>
<td>12 weeks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Osinusi et al. 2014] (LED/SOF; Harvoni)</td>
<td>12 weeks</td>
</tr>
<tr>
<td></td>
<td>Compensated cirrhosis</td>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily plus weight-based ribavirin twice daily [Wyles et al. 2015] (LED/SOF; Harvoni plus RBV; Copegus)</td>
<td>12 weeks</td>
</tr>
<tr>
<td></td>
<td>Compensated cirrhosis</td>
<td>Ledipasvir 90 mg/sofosbuvir 400 mg once daily [Bourliere et al. 2015; Bourliere et al. 2014] (LED/SOF; Harvoni)</td>
<td>24 weeks</td>
</tr>
<tr>
<td>1,2,3,4,5,6</td>
<td>No cirrhosis; compensated</td>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg/voxilaprevir 100 mg once daily [Bourliere et al. 2017; Gane et al. 2016] (SOF/VEL/VOX; Vosevi)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

*NS3/4A protease inhibitors: grazoprevir and paritaprevir
§NS5A polymerase inhibitors: daclatasvir, elbasvir, ledipasvir, ombitasvir, and velpatasvir
Table 31. Prior failure with a sofosbuvir-containing regimen that did not contain an NS5A inhibitor*  
No cirrhosis OR compensated cirrhosis  
Choose 1 of the following regimens for retreatment (AI):

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Cirrhosis Status</th>
<th>Regimens</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No cirrhosis</td>
<td><strong>No previous treatment with NS3/4A protease inhibitors</strong>: Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Poordad et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>1</td>
<td>Compensated cirrhosis</td>
<td><strong>No previous treatment with NS3/4A protease inhibitors</strong>: Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Poordad et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>16 weeks</td>
</tr>
<tr>
<td>1,2,3,4,5,6</td>
<td>No cirrhosis; compensated cirrhosis</td>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg/voxilaprevir 100 mg once daily [Gane et al. 2016] (SOF/VEL/VOX; Vosevi)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

*NS5A polymerase inhibitors: daclatasvir, elbasvir, ledipasvir, ombitasvir, and velpatasvir  
§ NS3/4A protease inhibitors: grazoprevir, paritaprevir, and voxilaprevir

Table 32. Prior failure with PEG-IFN plus RBV* and sofosbuvir • No cirrhosis OR compensated cirrhosis  
Choose 1 of the following regimens for retreatment (AI):

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Cirrhosis Status</th>
<th>Regimens</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,2,4,5,6</td>
<td>No cirrhosis; compensated cirrhosis</td>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Poordad et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>12 weeks</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Glecaprevir 300 mg/pibrentasvir 120 mg once daily [Poordad et al. 2017; FDA 2017] (GLE/PIB; Mavyret)</td>
<td>16 weeks</td>
</tr>
<tr>
<td>1,2,3,4,5,6</td>
<td></td>
<td>Sofosbuvir 400 mg/velpatasvir 100 mg/voxilaprevir 100 mg once daily [Bourliere et al. 2017; Gane et al. 2016] (SOF/VEL/VOX; Vosevi)</td>
<td>12 weeks</td>
</tr>
</tbody>
</table>

*Pegylated interferon plus ribavirin

References


Monitoring During DAA Treatment

Hepatitis C Virus Infection Guideline Committee, updated July 2018

✓ RECOMMENDATIONS

Monitoring of Patients Taking RBV
● While patients are taking ribavirin (RBV), clinicians should perform hemoglobin testing at weeks 2 and 4 of treatment and every 4 weeks thereafter until therapy is complete. (A1)

Monitoring of Patients Taking a DAA Protease Inhibitor
● In patients taking regimens that contain a DAA protease inhibitor (paritaprevir/ritonavir/ombitasvir/dasabuvir and elbasvir/grazoprevir), clinicians should monitor alanine aminotransferase (ALT) 4 weeks after initiating treatment and continue to obtain serum aminotransferase as needed according to the drug’s prescribing information. (A3)

Monitoring for HBV Reactivation
● In patients who are hepatitis B virus surface antigen (HBsAg) positive and have no detectable HBV DNA, clinicians should monitor for HBV reactivation by performing aspartate aminotransferase (AST), ALT, and HBV DNA tests every 4 weeks during HCV treatment. (A3)
● Clinicians new to HCV treatment should consult a liver disease specialist for further evaluation of patients who develop detectable HBV DNA. (A3)

Pregnancy
● If a woman becomes pregnant during therapy with a regimen containing RBV, clinicians should stop the RBV. (A1)
● If a woman becomes pregnant during therapy with any DAA regimen, clinicians should discuss with her the benefits and risks of using DAAs during pregnancy. (A3)

The adverse events associated with DAA treatment are listed in Table 33, below, and most are manageable. Patients who are taking RBV and experience insomnia may need to adjust the timing of the dose to earlier in the afternoon to avoid any sleep disruption.

Transient transaminase and bilirubin elevations may occur during the normal course of DAA therapy, but severe laboratory value elevations and rare hepatic decompensation have been reported with protease inhibitors during the treatment of patients with cirrhosis [FDA 2016b, 2017a, 2017b, 2017c; Hayashi et al. 2016]. Therefore, if at 4 weeks after treatment is initiated, the ALT level is elevated above baseline, testing should be repeated and levels monitored according to the drug’s prescribing information [FDA 2016b, 2017a, 2017b, 2017c; Hayashi et al. 2016].

HBV reactivation and HBV–related hepatic flares have occurred both during and after DAA therapy in patients who were not receiving HBV treatment [Takayama et al. 2016; Ende et al. 2015; Collins et al. 2015; De Monte et al. 2016; Sulkowski et al. 2016; Wang et al. 2017]. The U.S. Food and Drug Administration (FDA) has issued a drug safety warning regarding these risks.
### Table 33. Adverse Events Associated with DAAs

<table>
<thead>
<tr>
<th>Drug or Combination (brand name)</th>
<th>Most Common Adverse Reactions (proportion observed)</th>
</tr>
</thead>
</table>
| Elbasvir/grazoprevir (ELB/GRZ; Zepatier) | ▪ Fatigue, headache, nausea, insomnia, and diarrhea (≥5%)  
▪ With ribavirin: anemia and headache (≥5%) |
| Glecaprevir/pibrentasvir (GLE/PIB; Mavyret) | ▪ Headache and fatigue (>10%) |
| Ledipasvir/sofosbuvir (LED/SOF; Harvoni) | ▪ Asthenia, headache, and fatigue (≥10%) |
| Paritaprevir/ritonavir/ombitasvir (PTV/RTV/OBV; Technivie) | ▪ Asthenia, fatigue, nausea and insomnia (>10%) |
| Paritaprevir/ritonavir/ombitasvir/dasabuvir (PTV/RTV/OBV/DSV; PrOD; Viekira XR) | ▪ Nausea, pruritus, and insomnia (≥5%)  
▪ With ribavirin: fatigue, nausea, pruritus or other skin reactions, insomnia, and asthenia (>10%) |
| Ribavirin (Copegus) | ▪ Fatigue/asthenia, pyrexia, myalgia, and headache in adults receiving combination therapy (>40%) |
| Sofosbuvir (SOF; Sovaldi) | ▪ With ribavirin: fatigue and headache (≥20%) |
| Sofosbuvir/velpatasvir (SOF/VEL; Epclusa) | ▪ With velpatasvir/sofosbuvir: headache and fatigue (≥10%, all grades)  
▪ With velpatasvir/sofosbuvir and ribavirin in patients decompensated cirrhosis: fatigue, anemia, nausea, headache, insomnia, and diarrhea (≥10%, all grades) |
| Sofosbuvir/velpatasvir/voxilaprevir (SOF/VEL/VOX; Vosevi) | ▪ Headache, fatigue, diarrhea, and nausea (≥10%) |


### References


FDA. Daklinza (daclatasvir) tablets, for oral use. 2015a Jul. https://www.accessdata.fda.gov/drugsatfda_docs/label/2015/206843Orig1s000lbl.pdf [accessed 2017 Dec 18]


FDA. Harvoni (ledipasvir and sofosbuvir) tablets, for oral use. 2015b Mar. https://www.accessdata.fda.gov/drugsatfda_docs/label/2015/205834s000lbl.pdf [accessed 2017 Dec 18]


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NEW YORK STATE DEPARTMENT OF HEALTH AIDS INSTITUTE CLINICAL GUIDELINES PROGRAM

WWW.HIVGUIDELINES.ORG


FDA. Zepatier (elbasvir and grazoprevir) tablets, for oral use. 2016b Jan. https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/208261Orig1s000lbl.pdf [accessed 2017 Dec 19]


Drug–Drug Interactions

Hepatitis C Virus Infection Guideline Committee, updated July 2018

The charts contained in this section are meant to provide guidance on significant interactions between DAAs and common primary care medications. While these guidelines can be helpful, they are not a substitute for sound clinical judgement and practice.

In some cases, the medications listed below are contraindicated in the U.S. Food and Drug Administration (FDA) labeling for the medication, or the label may state elsewhere that co-administration is not recommended. For some, the recommendation may be to “Avoid Co-administration,” but in some clinical situations it may be necessary to use the medications concurrently. When this is the case, clinicians are encouraged to consult additional references or a liver disease specialist for additional guidance.

For more information on drug–drug interactions in patients with HIV/HCV coinfection see Treatment of Patients with HIV/HCV Coinfection > Drug–Drug Interactions between DAAs and ARVs in this guideline.

KEY POINT

▪ Although significant interactions associated with the use of DAAs and drugs used commonly in the treatment of substance use disorders are unlikely, care providers should always monitor for excess sedation when making alterations to a patient’s drug therapy while he/she is taking methadone, buprenorphine, naltrexone, and naloxone.

The following pages have tables for each of the following drugs:
▪ Elbasvir/Grazoprevir
▪ Glecaprevir/Pibrentasvir
▪ Ledipasvir/Sofosbuvir
▪ Paritaprevir/Ritonavir/Ombitasvir/Dasabuvir
▪ Sofosbuvir
▪ Sofosbuvir and Velpatasvir
▪ Sofosbuvir/Velpatasvir/Voxilaprevir

Box 3. Online Resources for Identifying Drug–Drug Interactions between DAAs and Common Medications

▪ American Association for the Study of Liver Diseases (AASLD)/Infectious Diseases Society of America (IDSA): Includes charts listing all DAAs
▪ University of Liverpool HEP Drug Interactions: Provides guidance on managing HCV drug interactions, especially in those coinfected with HIV; may not include all medications available in the United States
# Elbasvir/Grazoprevir

Hepatitis C Virus Infection Guideline Committee, December 2017

## Table 34. Elbasvir/Grazoprevir (Zepatier) Drug-Drug Interactions

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anticonvulsants</strong> (carbamazepine, phenytoin)</td>
<td>▪ Significant decrease in elbasvir/grazoprevir levels</td>
</tr>
<tr>
<td><strong>Antimycobacterial</strong> (rifampin)</td>
<td>▪ Significant decrease in elbasvir/grazoprevir levels</td>
</tr>
<tr>
<td><strong>Herbal product</strong> (St John’s wort)</td>
<td>▪ Significant decrease in elbasvir/grazoprevir levels</td>
</tr>
</tbody>
</table>
| **HIV medications** (efavirenz, atazanavir, darunavir, lopinavir, saquinavir, tipranavir) | ▪ Efavirenz: Significant decrease in elbasvir/grazoprevir levels  
▪ Atazanavir, darunavir, lopinavir, saquinavir, tipranavir: Significant increase in grazoprevir level  
▪ May lead to ALT elevation |
| **Immunosuppressant** (cyclosporine) | ▪ Significant increase in grazoprevir level  
▪ May lead to ALT elevation |

Co-administration possible; see clinical comments

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antibiotic</strong> (nafcillin)</td>
<td>▪ Decreased concentrations of elbasvir/grazoprevir levels</td>
</tr>
</tbody>
</table>
| **Antifungal** (ketoconazole) | ▪ Significant increase in elbasvir/grazoprevir levels  
▪ Increased risk of hepatotoxicity |
| **Endothelin antagonist** (bosentan) | ▪ Significant decrease in elbasvir/grazoprevir levels |
| **HMG-CoA reductase inhibitors** (atorvastatin, fluvastatin, lovastatin, rosuvastatin, simvastatin) | ▪ Increase in statin drug levels expected  
▪ Atorvastatin: Maximum daily dose 20 mg  
▪ Fluvastatin, lovastatin, or simvastatin: Use lowest doses possible; titrate with close monitoring  
▪ Rosuvastatin: Maximum daily dose 10 mg |
| **Immunosuppressant** (tacrolimus) | ▪ Significant increase in tacrolimus level expected  
▪ Frequent monitoring required for tacrolimus level, changes in renal function, and tacrolimus-associated adverse events |
| **Wakefulness-promoting agent** (modafinil) | ▪ Significant decrease in elbasvir/grazoprevir levels |

**Source:** U.S. Food and Drug Administration. Zepatier (elbasvir and grazoprevir) tablets, for oral use.  
https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/208261Orig1s000lbl.pdf [accessed 2017 Sep 22]
# Glecaprevir/Pibrentasvir

**Hepatitis C Virus Infection Guideline Committee, December 2017**

## Table 35. Glecaprevir/Pibrentasvir (Mavyret) Drug-Drug Interactions

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Avoid co-administration; see clinical comments</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Anticonvulsants (carbamazepine, phenobarbital, phenytoin) | • Carbamazepine: Significant decrease in glecaprevir/pibrentasvir levels expected  
• Phenobarbital, phenytoin: Significant decrease in glecaprevir/pibrentasvir levels possible |
| Antimycobacterial (rifampin) | • Significant decrease in glecaprevir/pibrentasvir levels expected |
| Ethinyl estradiol | • Increased risk of ALT elevations |
| Herbal therapy (St John’s Wort) | • Decreased glecaprevir/pibrentasvir levels expected |
| HIV medications (efavirenz, atazanavir, darunavir, lopinavir, saquinavir, tipranavir) | • Efavirenz: Significant decrease in glecaprevir/pibrentasvir levels expected  
• Atazanavir: Significant increase in glecaprevir/pibrentasvir levels expected; increased ALT elevations  
• Darunavir, lopinavir/ritonavir, other HIV protease inhibitors: Significant increase in glecaprevir/pibrentasvir levels expected |
| HMG-CoA reductase inhibitors (atorvastatin, lovastatin, simvastatin) | • Increased levels of atorvastatin, lovastatin, and simvastatin expected; do not co-administer  
• See note below regarding use of alternative statins |
| **Co-administration possible; see clinical comments** | |
| Antiarrhythmic (digoxin) | • Increased digoxin levels likely; reduce digoxin dosage 50%  
• Measure serum digoxin level prior to initiating therapy with glecaprevir/pibrentasvir |
| Anticoagulant (dabigatran etexilate) | • Refer to dabigatran prescribing information; follow dosage recommendations for concurrent use with P-glycoprotein inhibitors |
| HMG-CoA reductase inhibitors (fluvastatin, pitavastatin, pravastatin, rosuvastatin) | • Fluvastatin, pitavastatin: Increased statin levels likely; use lowest statin dosage and monitor for adverse events (e.g., myopathy)  
• Pravastatin: Increased statin level likely; reduce pravastatin dosage by 50% prior to initiating therapy with glecaprevir/pibrentasvir  
• Rosuvastatin: Increased statin level likely; do not exceed rosuvastatin 10 mg daily when combined with glecaprevir/pibrentasvir |
| Immunosuppressant (cyclosporine) | • Increased levels of glecaprevir/pibrentasvir expected; do not co-administer in patients requiring cyclosporine doses >100 mg daily |

**Source:** FDA. Mavyret (glecaprevir and pibrentasvir) tablets, for oral use. [http://www.natap.org/2017/HCV/mavyret_pi.pdf](http://www.natap.org/2017/HCV/mavyret_pi.pdf) [accessed 2017 Sep 22]
## Ledipasvir/Sofosbuvir

**Hepatitis C Virus Infection Guideline Committee, December 2017**

### Table 36. Ledipasvir/Sofosbuvir (Harvoni) Drug-Drug Interactions

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
</table>
| Antiarrhythmic (amiodarone) | • Significant bradycardia, especially in patients who are taking beta-blockers, have underlying cardiac abnormalities, or have advanced liver disease  
• If concurrent use is required, cardiac monitoring is recommended  
• See package insert for additional information |
| Herbal product (St John’s wort) | • Significant decrease in ledipasvir/sofosbuvir levels |
| Anticonvulsants (carbamazepine, oxcarbazepine, phenobarbital, phenytoin) | • Significant decrease in ledipasvir/sofosbuvir levels |
| Antimycobacterials (rifampin, rifabutin, rifapentine) | • Significant decrease in ledipasvir/sofosbuvir levels |
| HMG-CoA reductase inhibitor (rosuvastatin) | • Significant increase in rosvastatin level |
| NS3/4A HCV protease inhibitor (simeprevir) | • Significant increases in ledipasvir and simeprevir levels |

**Co-administration possible; see clinical comments**

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
</table>
| Antacids | • Ledipasvir solubility decreases as pH increases  
• Separate administration of aluminum- and magnesium-containing antacids and ledipasvir/sofosbuvir by 4 hours |
| Antiarrhythmic (digoxin) | • Increase in digoxin level expected  
• Monitor digoxin level |
| H2-receptor antagonists | • Administer simultaneously with, or 12 hours apart from, ledipasvir/sofosbuvir  
• Do not exceed doses comparable to famotidine 40 mg twice daily |
| Proton-pump inhibitors | • If co-administration is required, doses comparable to omeprazole 20 mg or lower can be administered simultaneously with ledipasvir/sofosbuvir under fasting conditions |

**Source:** FDA. Harvoni (ledipasvir and sofosbuvir) tablets, for oral use. https://www.accessdata.fda.gov/drugsatfda_docs/label/2015/205834s001lbl.pdf [accessed 2017 Sep 22]
### Table 37. Paritaprevir/Ritonavir/Ombitasvir/Dasabuvir (PrOD); Viekira XR Drug–Drug Interactions

Avoid co-administration; see clinical comments

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
</table>
| Alpha 1-antagonist (alfuzosin) | • Significant increase in alfuzosin level  
• Potential for severe hypotension |
| Antianginal (ranolazine) | • Significant increase in ranolazine level |
| Antiarrhythmics (amiodarone, dronedarone, dofetilide, disopyramide, flecainide, lidocaine, mexiletine, propafenone, quinidine) | • Increased antiarrhythmic drug levels, potential for cardiac arrhythmias  
• Therapeutic concentration monitoring of antiarrhythmic drug level recommended if available |
| Anticonvulsants (carbamazepine, oxcarbazepine, phenytoin, phenobarbital) | • Significant decrease in PrOD levels |
| Antigout (colchicine) | • Significant increase in colchicine level  
• Potential for renal impairment and pancytopenia |
| Antihyperlipidemic (gemfibrozil) | • Significant (10-fold) increase in dasabuvir level leading to increased risk of QT prolongation |
| Antimycobacterial (rifampin) | • Significant decrease in PrOD levels  
• Potential for HCV treatment failure |
| Antipsychotics, 1st generation, typical (pimozide, lurasidone) | • Significant increase in antipsychotic levels |
| Ergot derivatives (ergotamine, dihydroergot–amine, ergonovine, methylergonovine) | • Significant increase in ergot derivative level leading to acute ergot toxicity |
| Ethinyl estradiol–containing products (oral contraceptives) | • Significant increase in PrOD level  
• Alanine transaminase (ALT) elevations associated with concurrent use of ethinyl estradiol |
| Herbal product (St John’s wort) | • Significant decrease in PrOD levels |
| HIV medication (efavirenz) | • Co-administration of efavirenz–based regimens with paritaprevir, ritonavir plus dasabuvir poorly tolerated  
• Results in liver enzyme elevation |
| HMG–CoA reductase inhibitors (atorvastatin, lovastatin, simvastatin) | • Significant increase in atorvastatin, lovastatin, and simvastatin levels  
• Potential for rhabdomyolysis |
| Immunosuppressants (everolimus, sirolimus, tacrolimus) | • Increased potential for immunosuppressant–associated adverse events |
| Phosphodiesterase–5 inhibitors (sildenafil, when used in pulmonary arterial hypertension) | • Increased potential for sildenafil adverse events, such as priapism, visual disturbances, and hypotension |
| Sedative/hypnotics (oral midazolam, triazolam) | • Significant increases in oral midazolam or triazolam level |
### Table 37. Paritaprevir/Ritonavir/Ombitasvir/Dasabuvir (PrOD); Viekira XR Drug–Drug Interactions

Co-administration possible; see clinical comment

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
</table>
| Angiotensin receptor blockers (ARBs) (candesartan, olmesartan, telmisartan)        | • Increased ARB drug levels  
• Consider ARB dose reduction  
• Monitor closely for hypotension                                                                                                                                                                                                                                                                                                                                 | |
| Antifungal (oral ketoconazole, voriconazole)                                       | • Oral ketoconazole: Increase in ketoconazole level; dose should not exceed 200 mg in a 24-hour period  
• Voriconazole: Significant decrease in voriconazole level                                                                                                                                                                                                                                                                                                                                                     | |
| Antipsychotic, 2nd generation, atypical (quetiapine)                               | • Significant increase in quetiapine level  
• Consider alternative HCV therapy or reduce quetiapine dose to 1/6 of current dose  
• Monitor for adverse events, including increased blood pressure                                                                                                                                                                                                                                                                                       | |
| Beta adrenoceptor agonist (long-acting salmeterol)                                 | • Significant increase in salmeterol level  
• Monitor for QT prolongation, palpitations, and sinus tachycardia                                                                                                                                                                                                                                                                                                                                               | |
| Calcium channel blockers (CCBs) (amlodipine, diltiazem, felodipine, nicardipine, nifedipine, nisoldipine, verapamil) | • Increased CCB drug levels  
• Consider CCB drug dose reduction  
• Monitor closely for hypotension and bradycardia                                                                                                                                                                                                                                                                                                  | |
| Corticosteroids (inhaled or nasal fluticasone)                                     | • With nasal or inhaled use, significant increase in fluticasone level, which can lead to Cushing’s Syndrome                                                                                                                                                                                                                                                                                                                                                                    | |
| Diuretic (furosemide)                                                             | • Possible increase in furosemide level  
• Monitor closely based upon response                                                                                                                                                                                                                                                                                                                                                                               | |
| HMG-CoA reductase inhibitors (atorvastatin, pravastatin, rosuvastatin)            | • Increased HMG-CoA reductase inhibitor drug levels  
• Atorvastatin: Do not exceed 20 mg in a 24-hour period  
• Pravastatin: Do not exceed 40 mg in a 24-hour period  
• Rosuvastatin: Do not exceed 10 mg in a 24-hour period                                                                                                                                                                                                                                                                                                    | |
| Immunosuppressants (cyclosporine, tacrolimus)                                     | • Increase in cyclosporine and tacrolimus levels  
• Interactions are complex; consult PrOD package insert for additional dosing guidance                                                                                                                                                                                                                                                                                                                                 | |
| Muscle relaxants (carisoprodol, cyclobenzaprine)                                  | • Decrease in muscle relaxant drug levels  
• Consider increasing dose of muscle relaxant if clinically indicated                                                                                                                                                                                                                                                                                                                                         | |
| Narcotic analgesics (buprenorphine/naloxone, acetaminophen/hydrocodone)           | • Buprenorphine/naloxone: Monitor for sedation  
• Acetaminophen/hydrocodone: Reduce hydrocodone dose by 50%  
  ▫ Monitor for respiratory depression and sedation                                                                                                                                                                                                                                                                                                         | |
| Phosphodiesterase–5 inhibitors, when used for erectile dysfunction (sildenafil, tadalafil, vardenafil) | • Increase in phosphodiesterase–5 inhibitor drug level  
• Sildenafil: Do not exceed 25 mg in a 48-hour period  
• Tadalafil: Do not exceed 10 mg in a 72-hour period  
• Vardenafil: Do not exceed 2.5 mg in a 72-hour period                                                                                                                                                                                                                                                                                                | |
| Proton–pump inhibitor (omepazole)                                                  | • Decrease in omeprazole level  
• Consider increase in omeprazole dose for patients not well controlled  
• Do not exceed omeprazole 40 mg daily equivalent                                                                                                                                                                                                                                                                                                            | |
| Sedative/hypnotics (alprazolam, diazepam)                                          | • Alprazolam: Increase in drug level  
  ▫ Monitor for excess sedation  
• Consider decrease in alprazolam dose  
• Diazepam: Decrease in drug level  
  ▫ Consider increase in diazepam dose if clinically indicated                                                                                                                                                                                                                                                                                          | |

Source: FDA. Viekira XR (dasabuvir, ombitasvir, paritaprevir, and ritonavir) extended-release tablets, for oral use. https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/208624s001s003lbl.pdf [accessed 2017 Sep 22]
Sofosbuvir
Hepatitis C Virus Infection Guideline Committee, December 2017

Table 38. Sofosbuvir Drug-Drug (Sovaldi) Interactions

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiarrhythmic (amiodarone)</td>
<td>• Significant bradycardia, especially in patients who are taking beta-blockers, have underlying cardiac abnormalities, or have advanced liver disease.</td>
</tr>
<tr>
<td></td>
<td>▪ If concurrent use is required, cardiac monitoring is recommended</td>
</tr>
<tr>
<td></td>
<td>▪ See package insert for additional information</td>
</tr>
<tr>
<td>Anticonvulsants (carbamazepine, oxcarbazepine, phenobarbital, phenytoin)</td>
<td>• Significant decrease in sofosbuvir level expected leading to reduced sofosbuvir efficacy</td>
</tr>
<tr>
<td>Antimycobacterials (rifampin, rifabutin, rifapentine)</td>
<td>• Significant decrease in sofosbuvir level expected leading to reduced sofosbuvir efficacy</td>
</tr>
<tr>
<td>Herbal product (St John’s wort)</td>
<td>• Significant decrease in sofosbuvir level expected leading to reduced sofosbuvir efficacy</td>
</tr>
</tbody>
</table>

Source: FDA. Sovaldi (sofosbuvir) tablets, for oral use. https://www.accessdata.fda.gov/drugsatfda_docs/label/2015/204671s002lbl.pdf [accessed 2017 Sep 22]
**Sofosbuvir/Velpatasvir**

Hepatitis C Virus Infection Guideline Committee, December 2017

### Table 39. Sofosbuvir/Velpatasvir (Epclusa) Drug–Drug Interactions

**Avoid co-administration; see clinical comments**

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
</table>
| Antiarrhythmic (amiodarone)                            | • Significant bradycardia, especially in patients who are taking beta-blockers, have underlying cardiac abnormalities, or have advanced liver disease  
• If concurrent use is required, cardiac monitoring is recommended  
• See package insert for additional information |
| Anticonvulsants (carbamazepine, oxcarbazepine, phenobarbital, phenytoin) | • Significant decrease in sofosbuvir level expected, leading to reduced sofosbuvir and/or velpatasvir drug levels |
| Antimycobacterials (rifampin, rifabutin, rifapentine)   | • Potential significant decrease in sofosbuvir and/or velpatasvir drug levels     |
| Herbal product (St John’s wort)                        | • May significantly decrease sofosbuvir and/or velpatasvir drug levels             |

**Co-administration possible; see clinical comments**

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
</table>
| Antacids (aluminum and magnesium hydroxide)             | • May decrease concentration of velpatasvir  
• Separate administration of antacid and velpatasvir/sofosbuvir by 4 hours |
| Antiarrhythmic (digoxin)                               | • Increase in digoxin level expected  
• Monitor digoxin level |
| Anticancer (topotecan)                                 | • Significant increase in topotecan expected                                       |
| H2-receptor antagonist (famotidine)                    | • Velpatasvir solubility decreases as pH increases  
• May decrease concentration of velpatasvir  
• H2-receptor antagonists may be administered simultaneously with, or 12 hours apart from velpatasvir/sofosbuvir, at a dose that does not exceed doses comparable to famotidine 40 mg twice daily |
| HMG–CoA reductase inhibitor (rosuvastatin)             | • May significantly increase the concentration of rosuvastatin, which is associated with increased risk of myopathy, including rhabdomyolysis  
• Rosuvastatin may be administered at a dose not greater than 10 mg daily |
| Proton-pump inhibitor (omeprazole)                     | • May decrease concentration of velpatasvir  
• Proton–pump inhibitor doses comparable to omeprazole 20 mg or lower can be administered simultaneously with velpatasvir/sofosbuvir under fasting conditions |

**Source:** FDA. Epclusa (sofosbuvir and velpatasvir) tablets, for oral use. [https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/208341s000lbl.pdf](https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/208341s000lbl.pdf) [accessed 2017 Sep 22]
Table 40. Sofosbuvir/Velpatasvir/Voxilaprevir (Vosevi) Drug–Drug Interactions

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiarrhythmic (amiodarone)</td>
<td>• Potential for significant bradycardia, especially in patients who are taking beta-blockers, have underlying cardiac abnormalities, or have advanced liver disease if concurrent use is required, cardiac monitoring is recommended</td>
</tr>
<tr>
<td>Herbal product (St John’s wort)</td>
<td>• Significant decrease in sofosbuvir/velpatasvir/voxilaprevir levels</td>
</tr>
<tr>
<td>Anticonvulsants (carbamazepine, oxcarbazepine, phenobarbital, phenytoin)</td>
<td>• Significant decrease in sofosbuvir/velpatasvir/voxilaprevir levels</td>
</tr>
<tr>
<td>Antimycobacterials (rifampin, rifabutin, rifapentine)</td>
<td>• Significant decrease in sofosbuvir/velpatasvir/voxilaprevir levels</td>
</tr>
</tbody>
</table>
| HIV medications (efavirenz, atazanavir, tipranavir)                                | • Efavirenz: Significant decrease in velpatasvir and voxilaprevir levels expected  
• Atazanavir: Significant increase in voxilaprevir level expected  
• Tipranavir: Significant decrease in sofosbuvir and voxilaprevir levels expected                                                                                                                                                                                                                   |
| HMG–CoA reductase inhibitor (pitavastatin, rosuvastatin)                           | • Significant increase in pitavastatin and rosuvastatin levels expected when combined with sofosbuvir/velpatasvir/voxilaprevir                                                                                                                                                                                                                                   |
| Immunosuppressant (cyclosporine)                                                   | • Significant increases in cyclosporine level expected                                                                                                                                                                                                                                                                                                       |

Co-administration possible; see clinical comments

<table>
<thead>
<tr>
<th>Class (medications)</th>
<th>Clinical Comments</th>
</tr>
</thead>
</table>
| Acid reducing medications:                                                         | • Separate administration of antacids and sofosbuvir/velpatasvir/voxilaprevir by 4 hours  
• H2–receptor antagonists may be administered simultaneously with or staggered from sofosbuvir/velpatasvir/voxilaprevir at a dose that does not exceed a comparable dose of famotidine 40 mg twice daily  
• Omeprazole 20 mg can be administered with sofosbuvir/velpatasvir/voxilaprevir:  
  • Use with other proton pump–inhibitors has not been studied  
  • Use with lowest doses of other proton pump inhibitors is unlikely to interact  
| Antiarrhythmic (digoxin)                                                           | • Sofosbuvir/velpatasvir/voxilaprevir may increase digoxin levels; monitor digoxin levels closely prior to and during therapy                                                                                                                                                                                                                         |
| HIV medication (tenofovir disoproxil fumarate [TDF])                              | • Significant increase in TDF levels expected; monitor for tenofovir–related adverse events                                                                                                                                                                                                                                                        |
| HMG–CoA reductase inhibitor (atorvastatin, fluvastatin, lovastatin, pravastatin, simvastatin) | • Atorvastatin, fluvastatin, lovastatin, simvastatin: Potential increase levels of statins when combined with sofosbuvir/velpatasvir/voxilaprevir; use lowest statin dosage  
• Pravastatin: Potential increased levels of pravastatin when combined with sofosbuvir/velpatasvir/voxilaprevir; do not exceed pravastatin 40 mg daily when combined                                                                 |

Source: FDA. Vosevi (sofosbuvir and velpatasvir and voxilaprevir) tablets, for oral use. https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/209195s000lbl.pdf [accessed 2017 Sep 22]
Post-Treatment Care
Hepatitis C Virus Infection Guideline Committee, updated July 2018

🔹 RECOMMENDATIONS

Evaluating the Response to HCV Treatment
• Clinicians should perform HCV RNA testing 12 weeks after treatment is complete to verify that a sustained virologic response (SVR) has been achieved. (A1)
• If SVR is achieved, as established by undetectable HCV RNA at 12 weeks after treatment, clinicians should:
  ▫ Inform their patients that the HCV infection has been cured (A2)
  ▫ Explain the risk of HCV reinfection and that HCV antibodies are not protective against reinfection (A1)
• To assess for reinfection in patients with ongoing risk factors, clinicians should perform follow-up screening with HCV RNA testing (not HCV antibody testing) at least annually, even with a history of an SVR. (A1)
  ▫ For more information on patients with coinfection, see NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Treatment of Patients with HIV/HCV Coinfection > Post-Treatment Care for Patients with HIV and HCV
• If HCV RNA is detectable at 12 weeks after treatment, clinicians should:
  ▫ Inform patients that treatment has failed (A1)
  ▫ If new to HCV treatment, consult with a liver disease specialist for retreatment evaluation (B3)
  ▫ See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Regimens for Retreatment After DAA Failure

Post-Treatment Monitoring
• For patients taking ribavirin (RBV)-containing HCV treatment regimens, clinicians should:
  ▫ Advise female and male patients to take extreme care to avoid pregnancy for 6 months after completion of therapy (A2)
  ▫ Counsel female and male patients on effective contraceptive use (A2)
• If a woman becomes pregnant within 6 months of completing an RBV-containing HCV treatment, clinicians should discuss with her the risks of using DAAs and RBV during pregnancy. (A3)

Patients with Persistent Liver Disease
• Clinicians should evaluate patients with persistent abnormal transaminase levels after SVR for other causes of liver disease and consult with a liver disease specialist. (A3)
• In patients with underlying bridging fibrosis or cirrhosis, clinicians should screen for hepatocellular carcinoma (HCC) every 6 months. (A1)

After treatment for chronic HCV infection, follow-up care is based on individual patient factors, including response to recent treatment, previous treatment history, degree of hepatic fibrosis, comorbidities, and cofactors for other sources of liver injury, such as alcohol use or fatty liver disease.

Evaluating the Response to HCV Treatment
All treated individuals should have HCV RNA testing performed 12 weeks after treatment. If there is no detectable HCV RNA at 12 weeks, HCV infection has been cured. In the absence of recurrent risk factors, subsequent HCV testing is not required. However, with late relapse reported in rare (<0.5%) cases, some clinicians may choose to retest at 24 and/or 48 weeks after end of treatment [Jacobson et al. 2017].

Successful treatment of chronic HCV infection results in no detectable HCV RNA, but antibodies to HCV are typically retained for life. It is important for treated individuals to understand that they will continue to have antibodies but not active HCV infection. It is also important for patients to understand that, although antibodies to HCV will continue to be present after treatment, HCV antibodies do not offer protection from HCV reinfection. All individuals with no detectable HCV RNA are considered susceptible to reinfection if re-exposed to HCV. While the overall rate of reinfection is low, it is elevated among populations at higher risk [Martinello et al. 2017]. A meta-analysis of 59
studies reporting on recurrence after a sustained viral response (SVR) in 9,049 patients found that the summary 5-year risk of HCV reinfection among high-risk populations was 10.67% [Simmons et al. 2016]. High risk was defined as having one or more risk factors for reinfection (current or former persons who inject drugs [PWID], imprisonment, and men who have sex with men [MSM]). Among low-risk populations, defined as those with no known risk factors, the summary 5-year recurrence risk of was 0.95% [Simmons et al. 2016]. For discussion of risk factors, see Screening for HCV Infection and Diagnosis of HCV Infection in this guideline.

Post-Treatment Monitoring

It is important to monitor for the resolution of patients’ HCV treatment-related adverse events. RBV-containing regimens are teratogenic; patients receiving RBV-containing regimens and their partners should be counseled to avoid pregnancy during treatment and up to 6 months post-treatment. Two forms of effective birth control should be used [FDA 2011].

See Monitoring During DAA Treatment > Table 33: Adverse Events Associated with Direct-Acting Antiviral Agents for a list of adverse events associated with DAA regimens. During treatment with RBV, patients may experience hemolytic anemia, nausea, cough, shortness of breath, rash, dry skin, pruritus, lactic acidosis, or pancreatitis [FDA 2011]. Patients should be monitored through the follow-up period for resolution of any symptoms.

Hepatitis B virus (HBV) reactivation: HBV-related hepatic flares have been reported during and after DAA therapy in patients who were not receiving concurrent HBV treatment [Hayashi et al. 2016; Takayama et al. 2016; Ende et al. 2015; Collins et al. 2015; De Monte et al. 2016; Sulkowski et al. 2016; Wang et al. 2017]. The U.S. Food and Drug Administration (FDA) has issued a drug safety warning regarding these risks. Although data are insufficient to make a definitive recommendation regarding monitoring in the setting of isolated anti-HBc [AASLD/IDSA HCV Guidance Panel 2015], it is important to consider HBV reactivation as part of the differential diagnosis for patients with HBV infection who experience unexplained increases in liver enzymes either during or after completion of DAA treatment.

Patients with Persistent Liver Disease

Although cessation of the progression of fibrosis and histological improvement are among the benefits of treating chronic HCV infection [George et al. 2009; Tocaceli et al. 2003], patients should still be monitored for potential risk of post-treatment decompensation [Jacobson et al. 2017].

Individuals in whom HCV infection is cured remain at risk of liver disease progression if their baseline fibrosis is sufficiently advanced or if they have comorbidities, such as metabolic syndrome, alcohol use, or uncontrolled coinfection with HIV or HBV or are at risk of liver injury from drugs or dietary supplements [Vandenbulcke et al. 2016].

Although there is wide individual variation in the time needed for fibrosis progression to occur in chronic HCV infection, it is important to maintain an elevated level of suspicion for progression of fibrosis and the complications associated with hepatic decompensation, particularly in individuals with long-term chronic HCV infection or comorbidities that would predispose them to faster progression. Transient elastography is not available in all clinical settings, but once it is more widely available, it will aid in monitoring fibrosis progression after HCV treatment.

For patients with bridging fibrosis or cirrhosis, an ultrasound should be performed every 6 months, regardless of SVR, to screen for HCC [Jacobson et al. 2017]. The risk of HCC for patients with stage 3 or higher fibrosis is 1.5% to 5% per year, but it is not known whether the histologic improvement after successful treatment mitigates this risk [Bruix and Sherman 2011].

References


Treatment of Patients with HIV/HCV Coinfection

Hepatitis C Virus Infection Guideline Committee, updated July 2018

How to Use These Recommendations for Treating Patients with HIV and HCV

• Treatment of chronic HCV infection in patients with HIV requires attention to drug–drug interactions between DAAs and ARVs and to a few other HIV–specific treatment issues, detailed below.
• Otherwise, in treating patients with HIV/HCV coinfection, clinicians should follow the recommendations for the assessment, treatment, monitoring, and follow-up of patients with HCV monoinfection and consult a liver disease specialist and an experienced HIV care provider as needed.

RECOMMENDATIONS

Diagnosis of HCV Infection in People with HIV

• Clinicians should perform HCV screening at least once for patients with HIV; after that, decisions to screen should be based on any ongoing risk factors for HCV infection. (A2)
  ▫ See NYSDOH AI: Treatment of Chronic HCV with Direct-Acting Antivirals > Screening for HCV Infection and Treatment of Chronic HCV with Direct-Acting Antivirals > Diagnosis of HCV Infection
• In patients with HIV who have CD4 counts below 200 cells/mm³ and elevated alanine aminotransferase (ALT), clinicians should perform HCV RNA testing along with HCV antibody testing to evaluate for HCV infection. (A2)

Assessment of HBV Infection in Patients with HIV

• In patients who exhibit a pattern of isolated core antibody (cAb+) positivity, defined as cAb+ with negative surface antigen (sAg−) and surface antibody status (sAb−), clinicians should:
  ▫ Perform HBV DNA testing to assess for active HBV infection (A1)
  ▫ Vaccinate patients who have a negative HBV DNA test (B3)
• If an adjustment in antiretroviral therapy (ART) is required for compatibility with HCV treatment in patients who are HBV sAg+, clinicians should maintain use of tenofovir disoproxil fumarate (TDF) or tenofovir alafenamide fumarate (TAF) as part of the patient’s ART regimen. (A1)
  ▫ See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Pretreatment Assessment
  ▫ See NYSDOH AI guideline HBV–HIV Coinfection

Initiating DAA Treatment in Patients with HIV and HCV

• Clinicians should recommend initiation of ART for any patient with HIV/HCV coinfection who is not already receiving ART. (A1)
  ▫ See NYSDOH AI guideline When to Initiate ART
• Clinicians should not exclude patients with CD4 counts <200 cells/mm³ from HCV treatment. (A3)
• Clinicians should choose a DAA drug regimen that will not cause adverse DAA–ARV drug–drug interactions (see Box 4, below, Online Resources for Identifying Drug–Drug Interactions between DAAs and ARVs). (A3)
• Clinicians should prescribe DAA regimens for a minimum of 12 weeks in patients with HIV/HCV coinfection. Glecaprevir/pibrentasvir may be prescribed for 8 weeks in some patients. (A3)
  ▫ See NYSDOH AI: Treatment of Chronic HCV with Direct-Acting Antivirals > Recommended DAA Regimens
• Clinicians should consult with an experienced HIV care provider if a patient’s ART regimen must be changed to accommodate simultaneous treatment of HCV infection. (A3)

Drug–Drug Interactions between DAAs and ARVs

• When prescribing ledipasvir or velpatasvir to patients taking tenofovir disoproxil fumarate (TDF), clinicians should do one of the following:
  ▫ Substitute tenofovir alafenamide (TAF) for TDF, particularly when the creatinine clearance (CrCl) is <50 mL/min or the patient’s regimen also includes cobicistat or ritonavir (A3)
  ▫ Substitute abacavir (ABC) if the patient is human leukocyte antigen (HLA) B*5701 negative and does not have HBV sAg+, and if the patient has no evidence of prior HIV resistance to ABC (A3)
  ▫ Choose a different DAA regimen (A3)
Drug–Drug Interactions between DAAs and ARVs, continued

- Clinicians should assess for proteinuria and glucosuria at baseline and monitor creatinine clearance at weeks 2, 4, and 8 of a 12-week ledipasvir or velpatasvir regimen in patients who:
  - Must take TDF with dosing adjusted for renal issues as part of ART and have CrCl ≤50 mL/min (B3)
  - Are taking cobicistat or ritonavir (B3)

Post-Treatment Care for Patients with HIV and HCV

- Clinicians should perform follow-up HCV screening with an HCV RNA test at least annually in patients with ongoing risk factors for reinfection. (A1)
  - See NYSDOH AI: Treatment of Chronic HCV with Direct–Acting Antivirals > Screening for HCV Infection and Treatment of Chronic HCV with Direct–Acting Antivirals > Diagnosis of HCV Infection

  - In patients with underlying bridging fibrosis or cirrhosis, clinicians should screen for HCC every 6 months. (A1)
  - See NYSDOH AI: Treatment of Chronic HCV with Direct–Acting Antivirals > Post-Treatment Care

Prevalence and Consequences of HIV/HCV Coinfection

Due to the similar routes of transmission, HCV prevalence has been estimated to be six times higher in people with HIV than in those without HIV [Platt et al. 2016]. Approximately 25% of the 1.1 million [CDC 2017] people with HIV in the United States also have HCV (i.e., HIV/HCV coinfection) [CDC 2015]. For New York State, a rate of 25% indicates that more than 28,000 of the nearly 113,000 people with diagnosed HIV [NYSDOH 2016] also have HCV.

For decades, the prevalence and incidence of HCV infection was highest among people who acquired HIV through injection drug use (IDU). However, recent data suggest that sexual acquisition now accounts for the majority of new HCV infections in men with HIV who have sex with men [Vanhommerig et al. 2015; Hagan et al. 2015]. In a recent study conducted in Europe, Australia, and Canada, among HIV–infected MSM, HCV incidence significantly increased between 1990 and 2014 [van Santen et al. 2017]. Analyses of data from the Multicenter AIDS Cohort Study (MACS) in the United States and from a cohort of HIV–infected MSM in San Diego demonstrated a similar rise in HCV incidence among MSM [Witt et al. 2013; Chaillon et al. 2017].

HCV coinfection has been associated consistently with excess morbidity and mortality in people with HIV [Smith et al. 2014; Gjaerde et al. 2016; Lo Re et al. 2015]. Cohort studies have observed that approximately 30% of people with HIV/HCV coinfection have advanced fibrosis [Kirk et al. 2013] that places them at high risk for progression to end-stage liver disease and hepatocellular carcinoma (HCC) and in urgent need of treatment.

Use of DAAs in Patients with HIV/HCV Coinfection

Currently available DAA regimens are safe and highly effective in the treatment of HCV infection in patients with HIV, with cure rates similar to those in people with HCV monoinfection [Naggie et al. 2017; Osinusi et al. 2015; Wyles et al. 2017; Eron et al. 2014; Sulkowski et al. 2015a; Luetkemeyer et al. 2016; Del Bollo et al. 2016; Hawkins et al. 2016; Milazzo et al. 2017; Sogni et al. 2016; Ingiliz et al. 2016]. Successful HCV treatment has been associated with improvements in patient–reported outcomes and decreased liver–related mortality [Younossi et al. 2016; Simmons et al. 2015]. Successful treatment of HCV among HIV–infected MSM and people who inject drugs (PWID) may also have a secondary treatment–as–HCV prevention effect. In one recent study from the Netherlands, introduction of DAAAs for treatment of HCV infection was associated with lower rates of acute HCV infection in this population [Boerekamps et al. 2017]. Numerous drug–drug interactions between DAAAs and the antiretroviral (ARV) drugs used to treat HIV infection have been identified. However, with multiple U.S. Food and Drug Administration (FDA)–approved DAAAs and ARVs from different classes, simultaneous treatment of HIV and HCV is now possible for virtually all patients.

Diagnosis of HCV Infection in Patients with HIV Infection

One study of 1,174 people living with HIV examined risk factors for HCV infection without HCV antibody seroconversion and found that history of IDU, higher ALT, and CD4 count <200 cells/mm³ were associated with
HCV antibody negative but HCV RNA positive status. When all three factors were present, the prevalence of seronegative HCV infection was 24% [Chamie et al. 2007].

See Screening and Diagnosis in this guideline for more information.

**Pre-HCV-Infection Treatment Assessment of Fibrosis in People with HIV**

Patients with HIV/HCV infection generally have more advanced fibrosis at a younger age than patients with HCV monoinfection [Kirk et al. 2013], so an accurate assessment of and a plan for management of cirrhosis are essential. Available fibrosis staging modalities, including transient elastography, have been studied in the setting of HIV/HCV coinfection and are appropriate for staging fibrosis before HCV treatment [Kirk et al. 2013; Matta et al. 2016; Njei et al. 2016; Merchante et al. 2015; Schmid et al. 2015]. Biopsy is typically not needed (see discussion of biopsy in Pretreatment Assessment in this guideline).

If using noninvasive tests other than transient elastography, the individual biomarkers that contribute to the patient's test score should be considered because HIV infection itself or ARVs may affect some of the components [Cales et al. 2010; Martel-Laferriere et al. 2014; Guaraldi et al. 2009; Rodriguez et al. 2011; Singal et al. 2011]. Use of atazanavir can result in elevations of indirect bilirubin levels [FDA 2011]; therefore, when calculating Child-Turcotte-Pugh (CTP) or Model for End-Stage Liver Disease (MELD) scores, using the direct bilirubin value is preferred. Similarly, the FibroSure test uses total bilirubin as part of the algorithm to calculate fibrosis scores and therefore may be inaccurate in patients on atazanavir.

See Pretreatment Assessment > Fibrosis Assessment in this guideline for more information.

**Assessment of Hepatitis B Virus (HBV) Infection in People with HIV**

Given the shared transmission routes, HBV serostatus should be assessed by HBsAg, HbcAb, and HBsAb in all patients with HIV/HCV coinfection, and patients who are not immune should be vaccinated (see recommendations in Pretreatment Assessment in this guideline). Patients with HIV/HCV coinfection exhibit the pattern of isolated core antibody (cAb+) positivity (cAb+ with negative surface antigen) and surface antibody status (sAg- and sAb-) more frequently than patients with HCV monoinfection [Ponde et al. 2010].

As described in Treatment Options in this guideline, patients who are HBV sAg+ should be monitored for HBV reactivation during HCV treatment [Takayama et al. 2016; Sulkowski et al. 2016; Wang et al. 2017; Collins et al. 2015; Ende et al. 2015; De Monte et al. 2016; Hayashi et al. 2016]. However, because it is recommended that patients with HIV who are HBV sAg+ receive ART with activity against HBV, HBV flares or reactivation would not be expected in patients on appropriate therapy (see NYSDOH AI guideline HBV–HIV Coinfection). If ART adjustment is needed for compatibility with HCV treatment, then the patient's HBV status is an important factor in choosing an ARV regimen. If possible, patients who are HBV sAg+ should receive TDF or TAF as part of their ART. Lamivudine or emtricitabine are common components of ART regimens; however, as single agents, they are not adequate treatment for HBV. Patients treated with lamivudine alone have displayed a mutation associated with lamivudine resistance at 3 years [Lok et al. 2003].

See Pretreatment Assessment > HAV and/or HBV Immunity Status in this guideline for more information.

**Initiating DAA Treatment in Patients with HIV/HCV Coinfection**

A CD4 count <200/mm^3 is not a contraindication to HCV treatment. However, in most patients who have low CD4 counts and uncontrolled HIV infection, treatment of HIV should be prioritized over treatment of HCV to prevent complications of HIV infection. In the unusual circumstance that a patient cannot tolerate ART due to HCV-related liver disease, treating the liver disease would be the priority. In addition, patients with cirrhosis may have low CD4 counts due to splenic sequestration.

In clinical trials [Naggie et al. 2017; Osinusi et al. 2015; Wyles et al. 2017; Eron et al. 2014; Sulkowski et al. 2015a, 2015b; Luethke et al. 2016; Foster et al. 2015; 14–19,48,49] and real-world clinical cohorts [Del Bello et al. 2016; Hawkins et al. 2016; Milazzo et al. 2017; Sogni et al. 2016; Ingiliz et al. 2016], HCV treatment response to DAAAs in patients with HIV/HCV coinfection mirrors that of patients with HCV monoinfection, so the recommended regimens are the same for patients in both populations. A key factor in choosing a DAA regimen is compatibility
with the patient’s ART regimen. If patients are taking ART and HIV is poorly controlled, further assessment of adherence and possible HIV resistance may be needed before initiating HCV treatment.

In patients with HIV/HCV coinfection, the minimum duration of treatment for all available regimens is currently 12 weeks, with the exception of glecaprevir/pibrentasvir, which is prescribed for 8 weeks in some patients (see Recommended DAA Regimens). Shorter treatment regimens with other DAAs have not been extensively studied.

See Treatment Options and Drug–Drug Interactions in this guideline for more information.

### Drug–Drug Interactions between DAAs and ARVs

Use of DAAs concurrently with ART may lead to clinically relevant drug interactions. Table 41, below, lists the potential drug–drug interactions between DAA regimens and select ART regimens and Box 4, below, lists other resources on drug–drug interactions in patients with HIV/HCV coinfection.

Tenofovir is a nucleoside reverse transcriptase inhibitor used extensively in the treatment of HIV and HBV. Tenofovir drug concentrations, when taken in the disoproxil fumarate form (TDF), are increased in the setting of renal failure and when taken with elvitegravir and cobicistat and are highest with concurrent ritonavir use [German et al. 2015]. Use of TDF with velpatasvir or ledipasvir also increases the level of tenofovir [FDA 2015, 2016a]. When ledipasvir/sofosbuvir is administered with TDF concurrently with efavirenz or ritonavir–boosted atazanavir or darunavir, the TDF exposure may increase even further, raising concern for development of TDF–related nephrotoxicity [German et al. 2014, 2015]. These interactions are also likely to occur with the sofosbuvir/velpatasvir combination [FDA 2016a]. In addition, the use of TDF with sofosbuvir/velpatasvir/voxilaprevir may also increase tenofovir levels; switching from TDF to TAF, changing TDF to ABC, or monitoring for adverse renal effects would be appropriate in this setting [FDA 2017].

Close monitoring of creatinine clearance is recommended when ledipasvir/sofosbuvir, velpatasvir/sofosbuvir, or velpatasvir/sofosbuvir/voxilaprevir must be coadministered with TDF and efavirenz or a ritonavir–boosted protease inhibitor. Care providers should consider changing the patient’s ART regimen by switching from TDF to TAF or abacavir if the HIV virus is susceptible to these drugs. TAF is associated with much lower peak serum tenofovir concentrations [Garrison et al. 2015]. The current FDA label allows TAF formulations to be used in patients whose CrCl is as low as 30 mL/min [FDA 2016a].

### Box 4. Online Resources for Identifying Drug–Drug Interactions between DAAs and ARVs

- Northeast Caribbean AETC Antiretroviral Clinical Support Tools: DAA Drug Interactions Quick Guides for Clinicians:
  - Elbasvir/grazoprevir (Zepatier)
  - Glecaprevir/pibrentasvir (Mavyret)
  - Ledipasvir/sofosbuvir (Harvoni)
  - Ombitasvir/paritaprevir/ritonavir and dasabuvir (Viekira Pak)
  - Sofosbuvir/velpatasvir (Epclusa)
  - Sofosbuvir/velpatasvir/voxilaprevir (Vosevi)
- HCV Guidance: American Association for the Study of Liver Diseases (AASLD)/Infectious Diseases Society of America (IDSA): Includes charts listing all DAAs and their compatibility with ARVs
- University of Liverpool HEP Drug Interactions: Provides guidance on managing HCV drug interactions, especially in those who also have HIV; may not include all medications available in the United States
<table>
<thead>
<tr>
<th>ART Regimen</th>
<th>Concurrent DAA Regimen and Clinical Comment</th>
</tr>
</thead>
</table>
| ABC/3TC/DTG (Triumeq) [a] | • Preferred initial ART regimen [b]  
• Initiate only in patients with CrCl ≥50 mL/min  
• Initiate only in patients negative for HLA-B*5701 |
| TAF 25 mg/FTC/BIC (Biktarvy) | • Initiate only in patients with CrCl ≥30 mL/min  
• All DAA regimens are compatible |
| TAF 10 mg/FTC/Cubi/Evg (Genoya) [c,d] | • Preferred initial ART regimen [b]  
• Initiate only in patients with CrCl ≥30 mL/min  
• Do not co-administer with GRZ/ELB, PrOD |
| TAF 25 mg/FTC and DTG (Descovy and Tivicay) [d] | • Preferred initial ART regimen [b]  
• Initiate only in patients with CrCl ≥30 mL/min  
• All DAA regimens are compatible |
| TAF 25 mg/FTC and RAL HD (Descovy and Isentress) [d,e] | • Preferred initial ART regimen [b]  
• Initiate only in patients with CrCl ≥30 mL/min  
• All DAA regimens are compatible |
| TAF 25 mg/FTC/Rpv (Odefsey) [d, f] | • Alternative initial ART regimen [b]  
• Initiate only in patients confirmed to have:  
  ▫ CrCl of ≥30 mL/min  
  ▫ CD4 count ≥200 cells/mm³  
  ▫ Viral load <100,000 copies/mL  
• Do not co-administer with GRZ/ELB, PrOD  
• When combining TDF/FTC/Cubi/Evg with either LED/SOF, SOF/VEL/VOX, or VEL/SOF, plasma levels of tenofovir are increased and may lead to tenofovir-related renal side effects. Consider switching TDF to TAF, substituting ABC if patient is HLAB*5701 negative and has no evidence of ABC resistance, or using a different DAA regimen |
| TDF/FTC/Cubi/Evg (Stribild) [c] | • Alternative initial ART regimen [b]  
• Initiate only in patients with CrCl >70 mL/min  
• Do not co-administer with GRZ/ELB, GLE/Pib, PrOD  
• When combining TDF/FTC/Cubi/Evg with either LED/SOF, SOF/VEL/VOX, or VEL/SOF, plasma levels of tenofovir are increased and may lead to tenofovir-related renal side effects. Consider switching TDF to TAF, substituting ABC if patient is HLAB*5701 negative and has no evidence of ABC resistance, or using a different DAA regimen |
| TDF/FTC and DRV/Cubi (Truvada and Prezcobix) [c] | • Alternative initial ART regimen [b]  
• Initiate only in patients with CrCl ≥70 mL/min  
• Do not co-administer with GRZ/ELB, GLE/Pib, PrOD  
• When combining TDF/FTC and DRV/Cubi with either LED/SOF, SOF/VEL/VOX, or VEL/SOF, plasma levels of tenofovir are increased and may lead to tenofovir-related renal side effects. Consider switching TDF to TAF, substituting ABC if patient is HLAB*5701 negative and has no evidence of ABC resistance, or using a different DAA regimen |
| TDF/FTC and DRV and Rtv (Truvada and Prezista and Norvitr) [c] | • Alternative initial ART regimen [b]  
• Initiate only in patients with CrCl ≥50 mL/min  
• Do not co-administer with GRZ/ELB, GLE/Pib, PrOD  
• When combining TDF/FTC, DRV and Rtv with either LED/SOF, SOF/VEL/VOX, or VEL/SOF plasma levels of tenofovir are increased and may lead to tenofovir-related renal side effects. Consider switching TDF to TAF, substituting ABC if patient is HLAB*5701 negative and has no evidence of ABC resistance, or using a different DAA regimen |
<table>
<thead>
<tr>
<th>ART Regimen</th>
<th>Concurrent DAA Regimen and Clinical Comment</th>
</tr>
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| TDF/FTC and DTG (Truvada and Tivicay) | • Alternative initial ART regimen [b]  
• Initiate only in patients with CrCl ≥50 mL/min  
• When combining TDF with SOF/VEL/VOX, levels of tenofovir are increased and may lead to tenofovir-related renal side effects. Consider switching TDF to TAF, substituting ABC if patient is HLAB*5701 negative and has no evidence of ABC resistance, or using a different DAA regimen |
| TDF/FTC and RAL HD (Truvada and Isentress HD) | • Alternative initial ART regimen [b]  
• Initiate only in patients with CrCl ≥50 mL/min  
• When combining TDF with SOF/VEL/VOX, levels of tenofovir are increased and may lead to tenofovir-related renal side effects. Consider switching TDF to TAF, substituting ABC if patient is HLAB*5701 negative and has no evidence of ABC resistance, or using a different DAA regimen |
| TAF 25 mg/FTC and RAL (Truvada and Isentress HD) | • Alternative initial ART regimen  
• Initiate only in patients with CrCl ≥30 mL/min  
• All DAA regimens are compatible |

a. In all cases, FTC and 3TC are interchangeable when not being used in fixed-dose combinations.  
b. See NYSDOH AI guideline Selecting an Initial ART Regimen.  
c. Because of their drug–interaction profiles, COBI and RTV should not be considered interchangeable.  
d. TAF 10 mg and TAF 25 mg are not interchangeable.  
e. When dosing RAL once daily use the HD formulation of 600 mg tablets dosed at 1200 mg.  
f. When a “rapid start” or “test and treat” initiation of ART occurs before a patient’s viral load and CD4 count are available, avoid use of RPV

**Arv abbreviation key:** Abacavir (ABC); bictegravir (BIC); cobicistat (COBI); darunavir (DRV); dolutegravir (DTG); elvitegravir (EVG); emtricitabine (FTC); lamivudine (3TC); raltegravir (RAL); rilpivirine (RPV); ritonavir (RTV); tenofovir alafenamide (TAF); tenofovir disoproxil fumarate (TDF)

**DAA abbreviation key:** Elbasvir (ELB); glecaprevir (GLE); grazoprevir (GRZ); ledipasvir (LED); paritaprevir/ritonavir/ombitasvir/dasabuvir (PrOD); sofosbuvir (SOF); pibrentasvir (PIB); velpatasvir (VEL); voxilaprevir (VOX)

As new drug approvals for HIV ARVs and HCV DAAs continue, it is important that clinicians stay current on potential drug–drug interactions. Useful online resources for looking up potential drug–drug interactions and for monitoring for new information on drug–drug interactions are listed in Box 4, above.

**Post-Treatment Care for Patients with HIV/HCV Coinfection**

In patients with HIV, recent acquisition of HCV and/or ongoing risk behavior increase the risk of reinfection after treatment [Martinello et al. 2017; Young et al. 2017; Ingiliz et al. 2017]. The highest reinfection rates have been observed in European cohort studies of HIV–infected MSM; in a recent report, the 5-year HCV reinfection rate was 25% in those who cleared HCV spontaneously or were treated and achieved a sustained viral response (SVR) [Ingiliz et al. 2017].

In addition, patients with HIV/HCV coinfection develop HCC at a younger age than patients with HCV monoinfection, which underscores the need for ongoing screening in this population [Kirk et al. 2013].
References


All Recommendations
Hepatitis C Virus Infection Guideline Committee, December 2017

☑ ALL RECOMMENDATIONS: TREATMENT OF CHRONIC HCV WITH DAAS

Cohort-Based Screening
▪ REQUIREMENT: NYS Public Health Law mandates that primary care clinicians offer hepatitis C virus (HCV) screening to individuals born from 1945 to 1965 in a culturally and linguistically appropriate manner.
▪ See NYSDOH: Hepatitis C Testing Law

Risk-Based Screening
▪ Clinicians should perform HCV screening at least once for patients of any age who are not known to have HCV infection and currently have, or have a history that includes, any of the following risk factors:
  ▫ Injection drug use (A1)
  ▫ Intranasal drug use (A2)
  ▫ Sex partner(s) with HCV infection (A2)
  ▫ Incarceration (A2)
  ▫ Long-term hemodialysis (A1)
  ▫ Receipt of blood transfusion or organs before 1992, or of clotting factor concentrates from human plasma before 1987 (A1)
  ▫ A mother with a reactive HCV antibody test result (A1)
  ▫ Tattoo, piercing, or acupuncture obtained in a nonsterile setting (A2)
  ▫ HIV infection (A2)
  ▫ See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Treatment of Patients with HIV/HCV Coinfection > Diagnosis of HCV Infection in People with HIV
  ▫ Unexplained liver disease or abnormal transaminase levels (A1)
▪ Clinicians should offer HCV screening at least annually to individuals who are not known to have HCV infection and:
  ▫ Use injection drugs (A2)
  ▫ Use intranasal drugs (A2)
  ▫ Receive current long-term hemodialysis (A2)
▪ Clinicians should offer HCV screening at least annually to men who have sex with men (MSM) and to others who are not known to have HCV infection and:
  ▫ Engage in receptive anal sex and other behaviors that may tear mucous membranes (A2)
  ▫ Have multiple sex partners (A2)
  ▫ Engage in sex while using recreational mind-altering substances, particularly methamphetamine (A2)
  ▫ Have been diagnosed with another sexually transmitted infection (STI) within the previous 12 months (A2)
▪ Clinicians should perform HCV screening for individuals who are not known to have HCV infection and have a possible exposure in a healthcare setting, including those who:
  ▫ Have a break in the skin caused by a sharp object that is contaminated with blood, visibly bloody fluid, or other potentially infectious material or that has been in the source patient's blood vessel (A2)
  ▫ Have been bitten by an individual with visible bleeding in the mouth that causes bleeding in the exposed worker (A2)
  ▫ Have been splashed on a mucosal surface with blood, visibly bloody fluid, or other potentially infectious material (A2)
  ▫ Have non-intact skin (e.g., dermatitis, chapped skin, abrasion, or open wound) that has been exposed to blood, visibly bloody fluid, or other potentially infectious material (A2)

Continued next page
Screening Tests
- Clinicians should perform HCV screening using either a laboratory-based HCV antibody test or point-of-care rapid antibody test. (A1)
  - For the HCV testing sequence in patients with HIV and CD4 cell counts <200 mm$^3$, see NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Treatment of Patients with HIV/HCV Coinfection > Diagnosis of HCV Infection in People with HIV

Confirmatory Testing
- If the HCV antibody test result is reactive, clinicians should obtain confirmatory HCV RNA testing from a laboratory that uses a nucleic acid test (NAT) approved by the U.S. Food and Drug Administration (FDA). (A1)
- If HCV RNA is detected after a reactive antibody result, the patient has confirmed HCV infection and clinicians should evaluate for treatment of chronic or acute HCV infection. (A2)
- If the HCV antibody test result is nonreactive:
  - Clinicians should perform subsequent HCV screening based on individual patient risk factors (A3)
  - And if acute HCV infection is suspected, clinicians should perform a diagnostic HCV RNA test using an FDA-approved NAT (A1)
- In patients with a history of a reactive HCV antibody test, clinicians should use an HCV RNA test (not an HCV antibody test) for subsequent screening. (A1)

Acute HCV Infection
- Clinicians should suspect acute HCV infection if a patient who had a nonreactive antibody test documented within the previous 6 months has a new reactive antibody test or has detectable HCV RNA in the absence of a reactive antibody test. (A3)
- Clinicians should not prescribe pre- or post-exposure prophylaxis to prevent HCV infection. (A1)
- If chronic HCV infection is established, clinicians should evaluate patients for treatment. (A1)
  - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Pretreatment Assessment
- Clinicians should screen all patients with possible acute HCV infection for HIV, hepatitis A virus (HAV), and hepatitis B virus (HBV) infections, given the similar risk factors for acquisition. (A3)
  - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Pretreatment Assessment > Baseline Laboratory Testing

Who to Assess for Treatment
- Clinicians should assess all patients with a confirmed diagnosis of chronic HCV infection for treatment. (A1)

When to Refer to a Liver Specialist
- Clinicians new to treating chronic HCV infection should consult with a liver disease specialist when treating chronic HCV infection in patients with any of the following conditions (A3):
  - Compensated and decompensated cirrhosis
  - Concurrent hepatobiliary conditions
  - Extrahepatic manifestations of HCV, including renal, dermatologic, and rheumatologic manifestations
  - Significant renal impairment (creatinine clearance <30 mL/min) and/or undergoing hemodialysis
  - Active hepatitis B virus (HBV) infection, defined as HBV surface antigen positive and detectable HBV DNA
  - Ongoing HCV infection after failure of treatment with DAAs
- Clinicians new to treating chronic HCV infection should consult with a liver disease specialist when evaluating patients for retreatment after any DAA treatment failure. (B3)
  - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Regimens for Retreatment After DAA Failure
- Clinicians should refer patients with chronic HCV infection and decompensated liver disease and patients who are pre- or post-transplant to a liver disease specialist. (A3)
Medical History and Physical Exam
- See Table 2: Key Elements of a Pre–HCV Treatment Patient History and Physical Examination

HCV Genotype Testing
- Clinicians should obtain HCV genotype/subtype testing for all patients before starting treatment with direct-acting antivirals (DAAs). (A1)

Fibrosis Assessment
- Clinicians should assess the degree of fibrosis in patients with chronic HCV infection to aid in determining the following (A1):
  - Need for pretreatment screening for varices and hepatocellular carcinoma (HCC)
  - Duration of antiviral treatment
  - Need to include ribavirin (RBV) in the treatment regimen
  - Need for post–treatment follow-up
- Clinicians should assess patients with chronic HCV infection for decompensated liver disease. (A1)
- Clinicians should refer patients with decompensated cirrhosis to a liver disease specialist. (A3)

Cirrhosis Evaluation
- Clinicians should refer all patients with HCV-related cirrhosis for an upper endoscopy to screen for the presence of esophageal varices. (A3)
- Clinicians should screen for hepatocellular carcinoma (HCC) with ultrasound, computerized axial tomography (CT), or magnetic resonance imaging (MRI) every 6 months in patients with HCV–related bridging fibrosis or cirrhosis. (A3)

Baseline Laboratory Testing
- See Table 6: Baseline Laboratory Testing for Pre–HCV Treatment Assessment

Cardiovascular Status
- For individuals with chronic HCV infection who are aged >50 years, clinicians should perform cardiovascular risk assessment before initiation of treatment with ribavirin (RBV). (A2)

Renal Status
- Clinicians should assess creatinine clearance in all patients with HCV infection. (A1)
- Clinicians new to HCV treatment should consult a liver disease specialist when treating patients with severe renal impairment (creatinine clearance <30 mL/min). (A3)

Hepatitis A (HAV) and/or Hepatitis B (HBV) Immunity Status
- Clinicians should obtain HAV antibody (IgG or total) and administer the full HAV vaccine series in patients who are not immune to HAV. (A3)
- Clinicians should obtain HBV surface antigen (HBsAg), anti–hepatitis B surface (HBs), and anti–hepatitis B core antigen (HBC), total, and recommend administration of the anti–hepatitis B virus (HBV) vaccine series (0, 1, and 6 months) for HBV–susceptible patients (negative for all serologies). (A3)
  - In patients with positive HBsAg, clinicians should perform HBV DNA testing to assess for active HBV infection (A1)
  - For recommendations for patients with coinfection, see NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Treatment of Patients with HIV/HCV Coinfection > Assessment of HBV Infection in Patients with HIV
  - If HBV DNA is detectable, clinicians new to HCV treatment should consult a clinician experienced in the management of both HBV and HCV (A1)
ALL RECOMMENDATIONS: TREATMENT OF CHRONIC HCV INFECTION WITH DIRECT-ACTING ANTIVIRALS  

Pregnancy Status and Contraception

- Clinicians should perform a pregnancy test in all women of childbearing potential before initiation of HCV treatment and defer HCV treatment in pregnant women. (A2)
- Before initiating ribavirin (RBV), clinicians should (A2):
  - Confirm a negative pregnancy test
  - Advise patients to use 2 methods of birth control to avoid pregnancy during therapy and for 6 months after completion of therapy
  - Counsel female and male patients on effective contraceptive use

Contraindication:

- Clinicians should not use RBV in treatment of the following patients:
  - Female or male patients planning conception within 6 months of the last dose of RBV (A2)
  - Male patients who have pregnant partners (A2)
- Contraindication:
  - Clinicians should not use paritaprevir/ritonavir/ombitasvir/dasabuvir (PrOD) in treatment of women taking ethinyl estradiol–containing contraceptives. (A2)

Considerations in HCV Treatment

- Clinicians should assess creatinine clearance before initiating antiviral therapy. (A1)
- Clinicians new to HCV treatment should consult a liver disease specialist when treating patients who:
  - Have severe renal impairment (creatinine clearance <30 mL/min) and/or are undergoing hemodialysis (A3)
  - Require retreatment after treatment failure with any DAA regimen (B3)
    - See NYSDOH AI guideline *Treatment of Chronic HCV with Direct-Acting Antivirals* > Regimens for Retreatment After DAA Failure
- Clinicians should prescribe ribavirin (RBV) with caution for patients with a creatinine clearance <50 mL/min. (A1)
  - If prescribed, a reduced dose of 200 mg per day is required
  - Non-RBV–containing regimens can be prescribed without dose adjustments for patients with a creatinine clearance ≥30 mL/min

Contraindications

- Clinicians should not use RBV in treatment of the following patients:
  - Female or male patients planning conception within 6 months of the last dose of RBV (A2)
  - Male patients who have pregnant partners (A2)
- Clinicians should not use paritaprevir/ritonavir/ombitasvir/dasabuvir (PrOD) in treatment of women who are taking ethinyl estradiol–containing contraceptives. (A2)

Recommended DAA Regimens

- Based on the results of the pretreatment assessment, clinicians should choose from among the treatment regimens for patients with HCV genotypes 1a through 6 listed in tables 8 through 28.
- Clinicians should test for the presence of NS5A resistance–associated variants (RAVs) before starting therapy with elbasvir/grazoprevir in all patients with HCV genotype 1a infection. (AIII)
- If a regimen with weight–based RBV is chosen, clinicians should dose as follows: (A1)
  - <75 kg: RBV 400 mg once daily + 600 mg once daily (total daily dose: 1000 mg)
  - ≥75 kg: RBV 600 mg twice daily (total daily dose: 1200 mg):

Retreatment After Failure with Any DAA

- Clinicians new to HCV treatment should consult a liver disease specialist when retreating a patient who has failed treatment with any DAA regimen. (B3) Failure is defined as detectable HCV RNA 12 weeks after the conclusion of HCV treatment.
- If a regimen with weight–based ribavirin (RBV) is chosen, clinicians should dose as follows: (A1)
  - <75 kg: RBV 400 mg once daily + 600 mg once daily (total daily dose: 1000 mg)
  - ≥75 kg: RBV 600 mg twice daily (total daily dose: 1200 mg)
ALL RECOMMENDATIONS: TREATMENT OF CHRONIC HCV INFECTION WITH DIRECT-ACTING ANTIVIRALS  

Monitoring of Patients Taking RBV
- While patients are taking ribavirin (RBV), clinicians should perform hemoglobin testing at weeks 2 and 4 of treatment and every 4 weeks thereafter until therapy is complete. (A1)

Monitoring of Patients Taking a DAA Protease Inhibitor
- In patients taking regimens that contain a DAA protease inhibitor (paritaprevir/ritonavir/ombitasvir/dasabuvir and elbasvir/grazoprevir), clinicians should monitor alanine aminotransferase (ALT) 4 weeks after initiating treatment and continue to obtain serum aminotransferase as needed according to the drug’s prescribing information. (A3)

Monitoring for HBV Reactivation
- In patients who are hepatitis B virus surface antigen (HBsAg) positive and have no detectable HBV DNA, clinicians should monitor for HBV reactivation by performing aspartate aminotransferase (AST), ALT, and HBV DNA tests every 4 weeks during HCV treatment. (A3)
- Clinicians new to HCV treatment should consult a liver disease specialist for further evaluation of patients who develop detectable HBV DNA. (A3)

Pregnancy
- If a woman becomes pregnant during therapy with a regimen containing RBV, clinicians should stop the RBV. (A1)
- If a woman becomes pregnant during therapy with any DAA regimen, clinicians should discuss with her the benefits and risks of using DAAs during pregnancy. (A3)

Evaluating the Response to HCV Treatment
- Clinicians should perform HCV RNA testing 12 weeks after treatment is complete to verify that a sustained virologic response (SVR) has been achieved. (A1)
  - If SVR is achieved, as established by undetectable HCV RNA at 12 weeks after treatment, clinicians should:
    - Inform their patients that the HCV infection has been cured (A2)
    - Explain the risk of HCV reinfection and that HCV antibodies are not protective against reinfection (A1)
  - To assess for reinfection in patients with ongoing risk factors, clinicians should perform follow-up screening with HCV RNA testing (not HCV antibody testing) at least annually, even with a history of an SVR. (A1)
  - For more information on patients with coinfection, see NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Treatment of Patients with HIV/HCV Coinfection > Post-Treatment Care for Patients with HIV and HCV
- If HCV RNA is detectable at 12 weeks after treatment, clinicians should:
  - Inform patients that treatment has failed (A1)
  - If new to HCV treatment, consult with a liver disease specialist for retreatment evaluation (B3)
    - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Regimens for Retreatment After DAA Failure

Post-Treatment Monitoring
- For patients taking ribavirin (RBV)-containing HCV treatment regimens, clinicians should:
  - Advise female and male patients to take extreme care to avoid pregnancy for 6 months after completion of therapy (A2)
  - Counsel female and male patients on effective contraceptive use (A2)
- If a woman becomes pregnant within 6 months of completing an RBV-containing HCV treatment, clinicians should discuss with her the risks of using DAAs and RBV during pregnancy. (A3)

Patients with Persistent Liver Disease
- Clinicians should evaluate patients with persistent abnormal transaminase levels after SVR for other causes of liver disease and consult with a liver disease specialist. (A3)
- In patients with underlying bridging fibrosis or cirrhosis, clinicians should screen for hepatocellular carcinoma (HCC) every 6 months. (A1)
How to Use These Recommendations for Treating Patients with HIV and HCV

- Treatment of chronic HCV infection in patients with HIV requires attention to drug–drug interactions between DAAs and ARVs and to a few other HIV–specific treatment issues, detailed below.
- Otherwise, in treating patients with HIV/HCV coinfection, clinicians should follow the recommendations for the assessment, treatment, monitoring, and follow-up of patients with HCV monoinfection and consult a liver disease specialist and an experienced HIV care provider as needed.

Diagnosis of HCV Infection in People with HIV

- Clinicians should perform HCV screening at least once for patients with HIV; after that, decisions to screen should be based on any ongoing risk factors for HCV infection. (A2)
  - See NYSDOH AI: Treatment of Chronic HCV with Direct-Acting Antivirals > Screening for HCV Infection and Treatment of Chronic HCV with Direct-Acting Antivirals > Diagnosis of HCV Infection
- In patients with HIV who have CD4 counts below 200 cells/mm³ and elevated alanine aminotransferase (ALT), clinicians should perform HCV RNA testing along with HCV antibody testing to evaluate for HCV infection. (A2)

Assessment of HBV Infection in Patients with HIV

- In patients who exhibit a pattern of isolated core antibody (cAb+) positivity, defined as cAb+ with negative surface antigen (sAg-) and surface antibody status (sAb-), clinicians should:
  - Perform HBV DNA testing to assess for active HBV infection (A1)
  - Vaccinate patients who have a negative HBV DNA test (B3)
- If an adjustment in antiretroviral therapy (ART) is required for compatibility with HCV treatment in patients who are HBV sAg+, clinicians should maintain use of tenofovir disoproxil fumarate (TDF) or tenofovir alafenamide fumarate (TAF) as part of the patient’s ART regimen. (A1)
  - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Pretreatment Assessment
  - See NYSDOH AI guideline HBV–HIV Coinfection

Initiating DAA Treatment in Patients with HIV and HCV

- Clinicians should recommend initiation of ART for any patient with HIV/HCV coinfection who is not already receiving ART. (A1)
  - See NYSDOH AI guideline When to Initiate ART
- Clinicians should not exclude patients with CD4 counts <200 cells/mm³ from HCV treatment. (A3)
- Clinicians should choose a DAA drug regimen that will not cause adverse DAA–ARV drug–drug interactions (see Box 4, below, Online Resources for Identifying Drug–Drug Interactions between DAAs and ARVs). (A3)
  - Clinicians should prescribe DAA regimens for a minimum of 12 weeks in patients with HIV/HCV coinfection. Glecaprevir/pibrentasvir may be prescribed for 8 weeks in some patients. (A3)
  - See NYSDOH AI guideline Treatment of Chronic HCV with Direct-Acting Antivirals > Recommended DAA Regimens
- Clinicians should consult with an experienced HIV care provider if a patient’s ART regimen must be changed to accommodate simultaneous treatment of HCV infection. (A3)

Drug–Drug Interactions between DAAs and ARVs

- When prescribing ledipasvir or velpatasvir to patients taking tenofovir disoproxil fumarate (TDF), clinicians should do one of the following:
  - Substitute tenofovir alafenamide (TAF) for TDF, particularly when the creatinine clearance (CrCl) is <50 mL/min or the patient’s regimen also includes cobicistat or ritonavir (A3)
  - Substitute abacavir (ABC) if the patient is human leukocyte antigen (HLA) B*5701 negative and does not have HBV sAg+, and if the patient has no evidence of prior HIV resistance to ABC (A3)
  - Choose a different DAA regimen (A3)
- Clinicians should assess for proteinuria and glucosuria at baseline and monitor creatinine clearance at weeks 2, 4, and 8 of a 12-week ledipasvir or velpatasvir regimen in patients who:
  - Must take TDF with dosing adjusted for renal issues as part of ART and have CrCl ≤50 mL/min (B3)
  - Are taking cobicistat or ritonavir (B3)

Continued next page
Post-Treatment Care for Patients with HIV and HCV

- Clinicians should perform follow-up HCV screening with an HCV RNA test at least annually in patients with ongoing risk factors for reinfection. (A1)
  - See NYSDOH AI: Treatment of Chronic HCV with Direct-Acting Antivirals > Screening for HCV Infection and Treatment of Chronic HCV with Direct-Acting Antivirals > Diagnosis of HCV Infection
- In patients with underlying bridging fibrosis or cirrhosis, clinicians should screen for HCC every 6 months. (A1)
  - See NYSDOH AI: Treatment of Chronic HCV with Direct-Acting Antivirals > Post-Treatment Care
About this Guideline

July 2017

NYSDOH AIDS Institute Hepatitis C Virus Infection Guideline Committee

The NYSDOH AI protects and promotes the health of New York State's diverse population through disease surveillance and the provision of quality services for prevention, health care, and psychosocial support for those affected by HIV/AIDS, sexually transmitted diseases, viral hepatitis and related health concerns. In addition, the NYSDOH AI promotes the health of LGBT populations, substance users, and the sexual health of all New Yorkers. In response to the availability of effective new treatments for HCV, the AIDS Institute convened the Hepatitis C Virus Infection Guideline Committee in 2014 to develop a New York State guideline for the clinical care of HCV infection.

Committee Makeup

The members of the HCV committee (see Figure A1: HCV Committee Leaders, Members, and External Reviewers) were appointed by the NYSDOH AI to ensure representation of clinical practice in all major regions of the state, relevant medical disciplines and sub-specialties, key NYS agencies, community stakeholders, and patient advocates. Individuals confirmed as Committee members are required to disclose any potential conflicts of interest; disclosures are reviewed and approved by the NYSDOH AIDS Institute Office of the Medical Director (see Funding and Financial Disclosure of Potential Conflicts of Interest).

Committee Role

Committee members actively participate in guideline development, including evidence review, drafting of recommendations and text, manuscript review, consensus approval of all recommendations, and rating of recommendations.

Committee Leadership

The HCV Planning Group of committee leaders refined the manuscript, facilitated consensus approval of all recommendations, addressed feedback from external peer and consumer reviewers, and elicited input from other key AI guideline committees, including the Medical Care Criteria Committee (Adult HIV guidelines) and the Perinatal Transmission Prevention Committee.

Johns Hopkins University (JHU) Editorial Role

The JHU editorial team coordinated, guided, and documented all Committee activities, and edited the guideline material for clarity, flow, and style.

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- Christine A. Kerr, MD, Co-Chair
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Figure A1. Hepatitis C Virus Infection Guideline Committee: Leadership, Contributing Members, Liaisons, and Guideline Reviewers

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- Associate Medical Director for Science and Policy: Charles J. Gonzalez, MD, New York, NY
- Medical Director, Clinical Education Initiative: Cheryl A. Smith, MD, New York, NY
- Guidelines Program Coordinator: Laura Duggan Russell, MPH, Albany, NY
- Guidelines Program Coordinator (former): Tracy Hatton, MPH, New York, NY

AIDS Institute HIV Clinical Guidelines Program Committee Reviewers
- Medical Care Criteria Committee: Samuel T. Merrick, MD (Chair), New York–Presbyterian Hospital, New York, NY; Joseph P. McGowan, MD, FACP, FIDSA (Vice-Chair), Northwell Health, Manhasset, NY; Judith A. Aberg, MD, FIDSA, FACP (Chair Emeritus), Icahn School of Medicine at Mount Sinai, New York, NY
- Committee for the Prevention of Mother to Child Transmission of HIV: Rodney L. Wright, MD, MS (Co-Chair), Albert Einstein College of Medicine/Montefiore Medical Center, Bronx, NY

External Peer Reviewers
- Douglas T. Dieterich, MD, Icahn School of Medicine at Mount Sinai, New York, NY
- Ira M. Jacobson, MD, Mount Sinai Beth Israel, New York, NY
- Oluwaseun Falade-Nwulia, MBBS, MPH, Johns Hopkins University School of Medicine, Baltimore, MD
- Karla Thornton, MD, University of New Mexico School of Medicine, Albuquerque, NM
- Susan Lee, PharmD, BCPS, CDE, Hofstra–Northwell School of Medicine Manhasset, NY

*These individuals participated in the early development of the HCV guideline but were no longer in their positions, or were not able to serve as liaisons, at the conclusion of the project.
Funding and Disclosure of Potential Conflicts of Interest

July 2017

Funding

The Treatment of Chronic Hepatitis C Virus (HCV) with Direct-Acting Antivirals (DAAs) guideline was developed using New York State funds awarded as a grant to the Johns Hopkins University School of Medicine, Division of Infectious Diseases, from the New York State Department of Health AIDS Institute.

Conflicts of Interest

All active committee members, invited consultants and coauthors, peer reviewers, and program staff are required to disclose financial relationships with commercial entities, including gifts that may be actual conflicts of interest or may be perceived as conflicts. These individuals must disclose financial relationships annually, for themselves, their partners/spouses, and their organization/institution. On their annual disclosures, committee members are asked to report for the previous 12 months and the upcoming 12 months.

No conflicts were reported by the Committee Chair and Co-Chair, the majority of Committee members, and all NYSDOH AI and JHU program staff. Figure A2, below, lists the conflicts reported by eight Committee members.

Management of Potential Conflicts of Interest

All reported financial relationships with commercial entities are reviewed by the NYSDOH AI guidelines program to assess the potential for undue influence on guideline recommendations made by the Committee. For the Committee members reporting conflicts, it was determined that: 1) in this guideline, no individual drug or device is recommended over another; and 2) individual committee members reported concurrent conflicts with competing pharmaceutical companies.

Any potential for undue influence is also mitigated by the consensus process. All guideline recommendations received consensus approval of the full HCV Committee. The Committee Chairs and the NYSDOH AI Medical Director, none of whom reported conflicts of interest, performed the final review and approve the guideline.

All external reviewers, including peer reviewers and representatives from other NYSDOH AI Clinical Guidelines committees, were also required to submit conflict of interest/financial disclosure information, which were similarly screened. Three reviewers reported conflicts, which are listed in Figure A2.
### Figure A2. Reported Conflicts of Interest/Financial Disclosure Results

<table>
<thead>
<tr>
<th>Committee/Guideline Role</th>
<th>Relationships disclosed for the previous and upcoming 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Committee and Planning Group Member</td>
<td>• Consultant to: AbbVie, Bristol–Myers Squibb, Gilead, Merck, Research support from: Merck, AbbVie, Bristol–Myers Squibb, Gilead • Speakers' bureau for: BMS, Gilead, Merck, AbbVie</td>
</tr>
<tr>
<td>Committee Member</td>
<td>• Consultant to: Bristol–Myers Squibb, Gilead, and Viiv • Speaker: AbbVie, Janssen, Merck</td>
</tr>
<tr>
<td>Committee Member</td>
<td>• Consultant to: Gilead Sciences, Merck Pharmaceuticals, AbbVie</td>
</tr>
<tr>
<td>Committee Member</td>
<td>• Consultant to: Gilead, Bayer, Intercept: Consulting Research support from: AbbVie, Salix, Gilead, AbbVie • Speakers' bureau for: Merck, Bayer, Intercept, Gilead, AbbVie, Salix</td>
</tr>
<tr>
<td>Committee Member</td>
<td>• Advisory Board for: Gilead (Primary Care Advisory Board HCV) • Speakers' bureau for: AbbVie</td>
</tr>
<tr>
<td>Committee Member</td>
<td>• Consultant to: Roche Diagnostics Research support from: Gilead</td>
</tr>
<tr>
<td>Committee Member</td>
<td>• Consultant to: AbbVie Research support from: Gilead</td>
</tr>
<tr>
<td>Committee Member</td>
<td>• Research support from: BMS, Gilead, and Merck</td>
</tr>
<tr>
<td>NYSDOH AI Medical Care Criteria Committee Reviewer</td>
<td>• Consultant to: Merck Research support from: Viiv, Gilead</td>
</tr>
<tr>
<td>External Peer Reviewer</td>
<td>• Consultant to: AbbVie, Bristol–Myers Squibb, Gilead, Janssen, Merck</td>
</tr>
<tr>
<td>External Peer Reviewer</td>
<td>• Consultant to: AbbVie, Bristol–Myers Squibb, Gilead, Janssen, Merck: Achillion, Intercept, Trek Research support from: AbbVie, Bristol–Myers Squibb, Gilead, Janssen, Merck • Speakers bureau for: AbbVie, Bristol–Myers Squibb, Gilead, Janssen</td>
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</table>
## Evidence Collection and Review

July 2017

The NYSDOH AI guideline development process is based on a systematic search and analysis of the published evidence. Figure A1, below, illustrates the evidence review and selection process.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>HCV Committee defines the goal of the guideline: To provide evidence-based clinical recommendations for primary care management of chronic hepatitis C infection, including screening, diagnosis, pretreatment assessment, treatment options, and post-treatment monitoring</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>With individual authors, JHU editorial staff conducts a systematic literature search in PubMed using MESH terms. All searches limited to studies that 1) were published in the 5 years prior to the date of the literature search (see Table A3); 2) involved only human subjects; and 3) were published in English</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Authors review studies identified in searches; specific exclusion criteria include: 1) Studies involving interferon (IFN) treatment for chronic HCV infection; 2) Studies of HCV-associated comorbidities except those influencing HCV treatment decisions</td>
</tr>
</tbody>
</table>
| **Step 4** | Authors and editorial staff conduct additional searches using PubMed and online databases to identify:  
- Studies published prior to the 5-year search limit  
- Studies published during the guideline development process  
- Recent conference abstracts, such as the annual conferences of the American Association for the Study of Liver Diseases (AASLD) and the European Association for the Study of the Liver (EASL). Committee authors also consulted the HCV Guidance: Recommendations for Testing, Managing, and Treating Hepatitis C Infectious Diseases Society of America, a website produced by the AASLD and IDSA, which features current guidelines for treating HCV.  
- New York State epidemiologic data |
| **Step 5** | Development of guideline recommendations  
- Authors review evidence and draft recommendations  
- Planning Group members review, refine, and approve draft recommendations  
- Full committee reviews and reaches consensus on recommendations  
- Rating subcommittee reviews the cited evidence and assigns a two-part rating to each recommendation to indicate the strength of the recommendation and the quality of the supporting evidence; consensus is reached on ratings |
| **Step 6** | Ongoing Update Process  
- JHU editorial staff continue to collect evidence related to original searches and monitor for new drug approval  
- Planning Group reviews new evidence at least 3 times per year, more often if newly published studies, new drug approval, or drug-related warning indicates need for an immediate change to the published guideline  
- Committee reviews and approves changes to the guideline  
- Committee initiates a full review of guideline 4 years after the original publication date  
- NYSDOH AI publishes an update 5 years after the previous publication date |
Recommendation Development and Rating Process

July 2017

The clinical recommendations presented in this guideline were developed by consensus based on a synthesis of the current evidence collected through the systematic search described above. If no data were available, the recommendations are based on expert opinion, and this status is indicated in the rating and in the text.

The Planning Group met via monthly teleconferences over 18 months to finalize the guideline and reach consensus on recommendations and rationale. Once consensus among the Planning Group members was reached, the guideline was reviewed by the full HCV Committee, including consumer liaisons, and consensus was reached on all recommendations. These deliberations were conducted by teleconference; committee members were invited to submit comments in writing as well. Full committee review discussions were recorded, and recordings were reviewed carefully to ensure that all decisions and changes were captured and integrated into the manuscript.

Members of the Planning Group then individually reviewed the evidence for each recommendation and assigned a two-part rating (see below). The individual ratings were compiled into a report distributed to all raters, and conference call discussions were held to deliberate ratings for which consensus was needed. Once all raters agreed on the interpretation of evidence and ratings for all recommendations, the guideline was sent to the NYSDOH AI for review and approval.

<table>
<thead>
<tr>
<th>AIDS Institute HIV Clinical Guidelines Program Recommendations Rating Scheme</th>
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<tbody>
<tr>
<td><strong>Strength of Recommendation</strong></td>
</tr>
<tr>
<td>A = Strong</td>
</tr>
<tr>
<td>B = Moderate</td>
</tr>
<tr>
<td>C = Optional</td>
</tr>
</tbody>
</table>
External Review

July 2017

Five external peer reviewers recognized for their experience and expertise in the treatment of chronic HCV infection were identified by program leaders (see Figure A1: HCV Committee: Leadership, Contributing Members, Liaisons, and Guideline Reviewers). These individuals submitted a financial disclosure statement for the purpose of identifying potential conflicts of interest before participating as peer reviewers. Disclosure information is included in Figure A2: Reported Conflicts of Interest/Financial Disclosure Results.

Peer reviewers were asked to review the guideline for accuracy, balance, clarity, and practicality of the recommendations for primary care providers. The Planning Group addressed peer review feedback; any conflicting opinions were resolved by the Committee chairs.

Members of NYSDOH AI Medical Care Criteria Committee (Adult HIV Guidelines Committee) and the Perinatal Transmission Prevention Committee also provided reviews.
Guideline Updates

Members of the HCV Committee will monitor developments in the field of HCV treatment in an ongoing structured manner to maintain guideline currency. Once the guidelines are published on the program website: www.hivguidelines.org, any updates will be made to the HTML document as needed as treatment of chronic HCV with DAAs is a rapidly evolving field.

Notification of newly published studies will be automated, and the Planning Group will review new data at least every 4 months. Newly published data that provide support for existing recommendations will be cited in the text, and the studies will be added to the reference list(s).

If newly published data prompt a revision to recommendations or rationale, the Planning Group will propose appropriate edits and determine whether the changes warrant full committee review and approval. If full committee review is required, a conference call will be convened for that purpose.

If a new medication or formulation is approved, the Planning Group will be convened via conference call to examine the data, consider inclusion in the guideline, and determine the need for full committee review and approval.

The full guideline will be reviewed and updated on the 4th anniversary of publication to prepare for publication of an updated guideline on or before the 5th anniversary of publication.