

## HCV in Children

### Testing

#### Recommendations for HCV Testing of Perinatally Exposed Children and Siblings of Children With HCV Infection

RECOMMENDED	RATING 
All children born to HCV-infected women should be tested for HCV infection. Testing is recommended using an antibody-based test at or after 18 months of age.	I, A
Repetitive HCV RNA testing prior to 18 months of age is not recommended.	III, A
Children who are anti-HCV positive after 18 months of age should be tested with an HCV-RNA assay after age 3 to confirm chronic hepatitis C infection.	I, A
The siblings of children with vertically-acquired chronic HCV should be tested for HCV infection, if born from the same mother.	I, C

Although the prevalence of chronic hepatitis C is lower in children than adults, an estimated 3.5 to 5 million children worldwide have chronic HCV infection ([Indolphi, 2019](#)); ([Gower, 2014](#)). Data from the National Health and Nutrition Examination Survey (NHANES) indicate that 0.2% of 6- to 11-year-olds (31,000 children) and 0.4% of 12- to 19-year-olds (101,000 adolescents) in the US are HCV antibody positive ([Alter, 1999](#)).

As birth to a woman with chronic hepatitis C is a known risk for infection, children born to these women should be evaluated and tested for HCV. The rate of mother-to-child transmission (MTCT) of HCV infection is approximately 5%, although rates are higher among women with inadequately controlled HIV coinfection, and women with higher HCV-RNA levels, (>6 log<sub>10</sub> IU/mL) ([Benova, 2014](#)); ([Delotte, 2014](#)); ([Cottrell, 2013](#)); ([Shebl, 2009](#)). Identifying, following, and treating exposed children is recommended. The preferred assay for evaluation of HCV infection early in life is HCV-RNA testing, as maternal antibodies and consequently anti-HCV assay positivity may persist for 18 months ([Aniszewska, 2012](#)); ([England, 2005](#)). About 25% to 50% of infected infants spontaneously resolve HCV infection (loss of previously detectable HCV RNA) by 4 years of age ([Indolfi, 2019](#)); ([Garazzino, 2014](#)); ([Farmand, 2012](#)); ([Yeung, 2007](#)); ([EPHCVN, 2005](#)); ([Mast, 2005](#)).

There is considerable debate about the utility of HCV-RNA testing within the first year of life. Proponents argue that use of a highly sensitive RNA assay early in life can increase the rate of infected infants detected, and that a negative result strongly suggests the infant is not infected while a positive result helps identify HCV cases earlier. Proponents also want to seize opportunity to test in a patient group that is often lost to follow-up. Opponents argue that early testing does not change the need for definitive testing at or after 18 months; HCV RNA is more expensive than an antibody-based test; and there is no intervention or treatment that will occur prior to age 3—because of lack of approved drugs for this age group and to allow for possible spontaneous clearance. One large single center study demonstrated that HCV-RNA testing done in exposed infants aged 2 months to 6 months led to reliable positive and negative results that correlated with ultimate testing at 18 months ([Honegger, 2018](#)); ([Gowda, 2021](#)). Given these results and the value placed on enhancing HCV

elimination efforts by reducing missed opportunities for testing, the panel recommends considering HCV RNA testing as early as 2 months of age. There is no value in repeated HCV-RNA testing prior to 18 months of age, but anti-HCV testing should take place at or after 18 months of age.

## Transmission and Prevention

<b>Recommendations for Counseling Parents Regarding Transmission and Prevention in Children with HCV Infection</b>	
RECOMMENDED	RATING
Parents should be informed that hepatitis C is not transmitted by casual contact and, as such, children with HCV infection do not pose a risk to other children and can participate in school, sports, and athletic activities, and engage in all other regular childhood activities without restrictions.	I, B
Parents should be informed that universal precautions should be followed at school and in the home of children with HCV infection. Educate families and children about the risk and routes of HCV transmission, and the techniques for avoiding blood exposure, such as avoiding the sharing of toothbrushes, razors, and nail clippers, and the use of gloves and dilute bleach to clean up blood.	I, B

HCV-infected children often face discrimination and stigmatization in school and child-care settings that is driven by public misunderstanding regarding hepatitis C transmission. HCV is not transmitted by casual contact in the absence of blood exposure. Families should not be forced to disclose a child's HCV infection status, and children should not be restricted from any routine childhood activity.

The risk of sexual transmission of hepatitis C is considered very low/rare. Sexual transmission occurs but is generally inefficient except among HIV-infected men who have unprotected sex with men (see [HCV Testing and Linkage to Care](#)) ([Tieu, 2018](#)); ([Vaux, 2019](#)); ([Schmidt, 2014](#)). Adolescents with HIV infection and those with multiple sexual partners or sexually transmitted infections (STIs) should be encouraged to use barrier precautions to prevent sexual transmission of HCV and other STIs. Other adolescents with HCV infection should be counseled that the risk of sexual transmission is low but barrier precautions are recommended for other reasons (see [Testing and Linkage to Care: Table 2 - Measures to Prevent Transmission of HCV](#)).

## Monitoring and Medical Management

<b>Recommendations for Monitoring and Medical Management of Children With HCV Infection</b>	
RECOMMENDED	RATING
Routine liver biochemistries at initial diagnosis and at least annually thereafter are recommended to assess for disease progression.	I, C
Appropriate vaccinations are recommended for children with chronic HCV infection who are not immune to hepatitis B virus and/or hepatitis A virus to prevent these infections.	I, C
Disease severity assessment via routine laboratory testing and physical examination, as well as use	I, B

## Recommendations for Monitoring and Medical Management of Children With HCV Infection

of evolving noninvasive modalities (ie, elastography, imaging, or serum fibrosis markers) is recommended for all children with chronic HCV infection.	
Children with cirrhosis should undergo hepatocellular carcinoma (HCC) surveillance and endoscopic surveillance for varices per standard recommendations.	I, B
Hepatotoxic drugs should be used with caution in children with chronic HCV infection after assessment of potential risks versus benefits of treatment. Use of corticosteroids, cytotoxic chemotherapy, and/or therapeutic doses of acetaminophen are not contraindicated in children with chronic HCV infection.	II, C
Solid organ transplantation and bone marrow transplantation are not contraindicated in children with chronic HCV infection.	II, C
Anticipatory guidance about the potential risks of ethanol for progression of liver disease is recommended for adolescents with chronic HCV infection and their families. Abstinence from alcohol and interventions to facilitate cessation of alcohol consumption, when appropriate, are advised for all persons with chronic HCV infection.	I, C

Liver disease due to chronic HCV infection generally progresses slowly in children, and cirrhosis and liver cancer occur infrequently. Although elevated serum aminotransferase levels are often noted, HCV-infected children younger than 3 years virtually never develop advanced liver disease.

The initial assessment of children with chronic HCV infection includes exclusion of other causes of liver disease, assessment of disease severity, and detection of extrahepatic manifestations. Testing for concomitant HBV (HBsAg, anti-HBc, and anti-HBs), HIV (anti-HIV), and immunity to HAV (anti-HAV IgG) are recommended due to shared risk factors and the need to vaccinate nonimmune children who may not have received routine childhood HAV and HBV vaccines.

Disease staging in children can be accomplished via physical examination and assessment of routine laboratory parameters including albumin, serum hepatic aminotransferase levels, total bilirubin, international normalized ratio (INR), and platelet count every 6 to 12 months. Serum fibrosis markers also hold promise to stratify disease severity but require further validation ([Nielsen, 2019](#)); ([Pokorska-Spiewak, 2017](#)); ([Mack, 2012](#)). Of note, serum aminotransferase levels are not consistently reflective of disease severity in children. In one study, nearly 33% of children had normal aminotransferase levels despite substantial necroinflammation on biopsy ([Casiraghi, 2004](#)).

For children in whom advanced liver disease is a concern, liver imaging to evaluate for splenomegaly or venous collaterals is recommended initially, using liver ultrasound instead of CT or MRI due to its widespread availability and lack of ionizing radiation. Although liver biopsy is considered the gold standard regarding the grade of inflammation and stage of fibrosis, sampling artifact is problematic and most patients and practitioners prefer noninvasive alternatives, such as liver elastography, to determine the presence/absence of cirrhosis, particularly in children. Ultrasound-based liver elastography in children requires the use of specialized probes and cutoff values for advanced fibrosis/cirrhosis that differ from those used in adults, but this approach appears promising for monitoring children with chronic HCV infection ([Behairy, 2016](#)); ([Geng, 2016](#)); ([Lee, 2013](#)).

Due to the slow rate of fibrosis progression among children, there are few, if any, established bona fide risk factors for disease progression. Development of advanced liver disease in children is infrequent until more than 30 years of infection ([Jhaveri, 2011](#)); ([Goodman, 2008](#)); ([Minola, 2002](#)). However, as in adults, children with comorbid disease—such as obesity with nonalcoholic fatty liver disease and congenital heart disease with elevated right heart pressures—and those receiving hepatotoxic drugs should be monitored carefully for disease progression.

Hepatocellular carcinoma (HCC) is rarely encountered among children and has been reported almost exclusively in those with cirrhosis. There are reports that children with chronic HCV infection and a history of childhood leukemia may be at increased risk of developing HCC but evidence is limited ([González-Peralta, 2009](#)). In children with cirrhosis, liver ultrasound with or without serum alpha-fetoprotein (AFP) testing every 6 months is recommended for HCC surveillance per AASLD guidelines ([Marrero, 2018](#)). A baseline endoscopy is advisable to detect esophageal varices in children with cirrhosis and every 3 years thereafter in the absence of viral clearance. After successful antiviral therapy, the risk for cirrhosis complications decreases substantially.

In children with advanced fibrosis from chronic HCV infection, medications that are known to accelerate hepatic fibrosis (eg, methotrexate) should be avoided, if possible. Similarly, abstinence from alcohol use is strongly advised to minimize disease progression. Although corticosteroids and other immunosuppressants may enhance HCV replication, they are not contraindicated in children with HCV infection and should be prescribed for appropriate indications based on overall risks versus benefits. Of note, icteric flares of HCV—as reported in children and adults with chronic HBV—have not been reported in children receiving an organ transplant or cytotoxic chemotherapy. Although underlying liver disease is a risk factor for development of sinusoidal obstruction syndrome following bone marrow transplantation, the presence of HCV infection should not delay this therapy.

To remain well, untreated children with chronic hepatitis C are encouraged to maintain a healthy body weight due to the known deleterious effects of insulin resistance on fibrosis progression with HCV infection ([Kukla, 2015](#)); ([Petta, 2011](#)); ([Cua, 2008](#)); ([Moucari, 2008](#)). Commonly used medications, such as antimicrobial agents, antiepileptics, and cardiovascular agents, should be dosed per standard recommendations. However, nonsteroidal anti-inflammatory drugs and aspirin should be avoided, if possible, in children with cirrhosis and esophageal varices due to concerns of gastrointestinal bleeding and nephrotoxicity. Acetaminophen is a safe and effective analgesic for children with chronic HCV infection when dosed per package insert recommendations.

## Whom and When to Treat Among Children and Adolescents With HCV Infection

Recommendations for Whom and When to Treat Among Children and Adolescents With HCV Infection	
RECOMMENDED	RATING 
Direct-acting antiviral (DAA) treatment with an approved regimen is recommended for all children and adolescents with HCV infection aged $\geq 3$ years as they will benefit from antiviral therapy, regardless of disease severity.	I, B
The presence of extrahepatic manifestations—such as cryoglobulinemia, rashes, and glomerulonephritis—as well as advanced fibrosis should lead to early antiviral therapy to minimize future morbidity and mortality.	I, C

HCV-related, advanced liver disease is uncommon during childhood. However, liver disease progresses over time with increasing fibrosis severity ([Indolfi, 2019](#)); ([Mizuochi, 2018](#)); ([Bortolotti, 2008](#)); ([EPHCVN, 2005](#)); ([Resti, 2003](#)). Although uncommon, cirrhosis occurs occasionally in children and adolescents (aged  $< 18$  years) with HCV infection. Children have a long life expectancy during which HCV complications may develop. Children and adolescents with HCV infection may also transmit the virus to others.

The high success rates with DAA regimens in adults with chronic HCV infection have been replicated in the pediatric population. Clinical trial data evaluating DAA regimens in children and adolescents have allowed expanded use of these

safe, well-tolerated, efficacious HCV therapies in the pediatric population. Treatment of children as young as 12 years is predicted to be very cost-effective with currently approved DAA regimens as well as those in clinical trials ([Nguyen, 2019b](#)). Another cost-utility analysis compared DAA treatment at age 6 versus delaying treatment until age 18. The researchers reported the incremental cost-utility ratio for early vs delayed DAA therapy was <\$12,000 per QALY gained. They concluded that treatment during early childhood is cost-effective and delaying therapy until early adulthood may result in increased lifetime risk of complications of late-stage liver disease ([Greenway, 2019](#)). FDA-approved DAA regimens are available for children aged 3 to <18 years with any genotype of HCV.

## HCV Antiviral Therapy for Children and Adolescents, Without Cirrhosis or With Compensated Cirrhosis (Child-Pugh A)

Recommended regimens listed by pangenotypic, evidence level and alphabetically for

### Treatment-Naive or Interferon-Experienced Children and Adolescents Without Cirrhosis or With Compensated Cirrhosis<sup>a</sup>

RECOMMENDED	DURATION	RATING 
Combination of glecaprevir/pibrentasvir (weight-based dosing; see Table 1) for children aged $\geq 3$ with any genotype <sup>b</sup>	8 weeks	I, B
Combination of sofosbuvir/velpatasvir (weight-based dosing; see Table 2) for children $\geq 3$ of age with any genotype	12 weeks	I, B
Combination of ledipasvir/sofosbuvir (weight-based dosing; see Table 3) for children aged $\geq 3$ years with genotype 1, 4, 5, or 6	12 weeks	I, B

<sup>a</sup> Child-Pugh A  
<sup>b</sup> A longer duration of therapy (ie, 16 weeks) may be needed for genotype 3 interferon-experienced patients.

Recommended regimens listed by pangenotypic, evidence level and alphabetically for

### DAA-Experienced Children and Adolescents, Without Cirrhosis or With Compensated Cirrhosis<sup>a</sup>

RECOMMENDED	DURATION	RATING 
<b>Genotype 1, 2, 4, 5, or 6:</b> Daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) for adolescents aged $\geq 12$ years or weighing $\geq 45$ kg with prior exposure to an interferon-based regimen ( $\pm$ ribavirin) and/or sofosbuvir but no exposure to NS3/4A or NS5A protease inhibitors, without cirrhosis	8 weeks	I, C
<b>Genotype 1, 2, 4, 5, or 6:</b> Combination of glecaprevir/pibrentasvir (weight-based dosing; see Table 1) with prior exposure to an interferon-based regimen ( $\pm$ ribavirin) and/or sofosbuvir but no exposure to NS3/4A or NS5A protease inhibitors, with compensated cirrhosis <sup>a</sup>	12 weeks	I, C
<b>Genotype 3:</b> Combination of glecaprevir/pibrentasvir (weight-based dosing; see	16 weeks	I, C

Recommended regimens listed by pangenotypic, evidence level and alphabetically for

## DAA-Experienced Children and Adolescents, Without Cirrhosis or With Compensated Cirrhosis<sup>a</sup>

Table 1) with prior exposure to an interferon-based regimen ( $\pm$ ribavirin) and/or sofosbuvir but no exposure to NS3/4A or NS5A protease inhibitors, without cirrhosis or with compensated cirrhosis <sup>a</sup>		
<b>Genotype 1- 6:</b> Combination of glecaprevir/pibrentasvir (weight-based dosing; see Table 1) with prior exposure to NS3/4A protease inhibitors but no NS5A inhibitor exposure, without cirrhosis or with compensated cirrhosis <sup>a</sup>	12 weeks	I, C
<b>Genotype 1- 6:</b> Combination of glecaprevir/pibrentasvir (weight-based dosing; see Table 1) with prior exposure to an NS5A inhibitor but no NS3/4A protease inhibitor exposure, without cirrhosis or with compensated cirrhosis <sup>a</sup>	16 weeks	I, C
<b>Genotypes 1-6:</b> Combination of sofosbuvir/velpatasvir (weight-based dosing; see Table 2) with prior exposure to an interferon-based regimen ( $\pm$ ribavirin) and/or sofosbuvir but no exposure to NS3/4A or NS5A protease inhibitors, without cirrhosis or with compensated cirrhosis	12 weeks	I, C
<b>Genotypes 1-6:</b> Combination of sofosbuvir/velpatasvir (weight-based dosing; see Table 2) with weight-based ribavirin (see Table 4) with prior exposure to an interferon-based regimen ( $\pm$ ribavirin) and/or sofosbuvir but no exposure to NS3/4A or NS5A protease inhibitors, with decompensated cirrhosis	12 weeks	I, C
<b>Genotype 4, 5, or 6:</b> Combination of ledipasvir/sofosbuvir (weight-based dosing; see Table 3) for children and adolescents aged $\geq 3$ years with prior exposure to an interferon ( $\pm$ ribavirin) plus an HCV protease inhibitor regimen, without cirrhosis or with compensated cirrhosis <sup>a</sup>	12 weeks	I, C
<b>Genotype 1:</b> Combination of ledipasvir/sofosbuvir (weight-based dosing; see Table 3) for children and adolescents aged $\geq 3$ years with prior exposure to an interferon ( $\pm$ ribavirin) plus an HCV protease inhibitor regimen, without cirrhosis	12 weeks	I, C
<b>Genotype 1:</b> Combination of ledipasvir/sofosbuvir (weight-based dosing; see Table 3) for children and adolescents aged $\geq 3$ years with prior exposure to an interferon ( $\pm$ ribavirin) plus an HCV protease inhibitor regimen, with compensated cirrhosis <sup>a</sup>	24 weeks	I, C

<sup>a</sup> Child-Pugh A

**Table 1: Weight-Based Dosing of Glecaprevir/Pibrentasvir for Children Aged  $\geq 3$  Years of Age**

Body Weight	Once Daily Dose of Glecaprevir/Pibrentasvir
<20 kg	150 mg/60 mg
$\geq 20$ kg to <30 kg	200 mg/80 mg

Body Weight	Once Daily Dose of Glecaprevir/Pibrentasvir
≥30 kg to <45 kg	250 mg/100 mg
45 kg and greater or 12 years of age and older	300 mg / 120 mg / day

**Table 2: Weight-based dosing for sofosbuvir/velpatasvir fixed dose combination in children  $\geq 3$  years of age**

Body Weight	Once Daily Dose of Sofosbuvir/Velpatasvir
< 17 kg	150 mg/37.5 mg
17 - < 30 kg	200 mg/50 mg
$\geq 30$ kg	400 mg/100 mg

**Table 3. Weight-Based Dosing of Ledipasvir/Sofosbuvir for Children Aged ≥3 Years**

Body Weight	Once Daily Dose of Ledipasvir/Sofosbuvir
<17 kg	33.75 mg/150 mg
17 to <35 kg	45 mg/200 mg
≥35 kg	90 mg/400 mg per day

**Table 4. Weight-Based Dosing of Ribavirin for Children Aged ≥3 Years**

Body Weight	Daily Dose of Ribavirin (divided AM and PM)
<47 kg	15 mg/kg
47 to 49 kg	600 mg
50 to 65 kg	800 mg
66 to 80 kg	1000 mg
>80 kg	1200 mg

## Glecaprevir/Pibrentasvir

The daily fixed-dose combination of glecaprevir (300 mg)/pibrentasvir (120 mg) was approved for adolescents aged 12 through 17 years in April 2019. In the registration trial, 47 adolescents were treated with the adult-approved coformulated preparation; the duration of treatment was based on viral genotype, prior treatment, and cirrhosis status ([Jonas, 2019](#)). Genotypes 1 through 4 were represented in the trial. Two participants were HIV coinfecting, none had cirrhosis, and 11 had a prior treatment failure with peginterferon/ribavirin. SVR12 was 100%. The study drugs were well tolerated with no serious adverse events and no drug discontinuations.

Although there are no data from the adolescent population, EXPEDITION-8 evaluated 8 weeks of glecaprevir/pibrentasvir among 343 treatment-naive adults with genotype 1, 2, 3, 4, 5, or 6 and compensated cirrhosis. Overall SVR12 rates were 99.7% (334/335) in the per-protocol population and 97.7% (335/343) in the intention-to-treat population ([Brown, 2019](#)). Similarly, FDA approval and HCV guidance panel HCV treatment recommendations for DAA-experienced adolescents are based on clinical trial data from adults ([Asselah, 2018b](#)); ([Puoti, 2018](#)); ([Wyles, 2018](#)); ([Zeuzem, 2018](#)); ([Forns, 2017](#)).

Part 2 of the DORA trial examined the pharmacokinetics, safety and efficacy of glecaprevir/pibrentasvir among children aged 3 to <12 years with HCV of any genotype who were treatment naive or interferon/ribavirin experienced. Although the trial was designed to include children with compensated cirrhosis, none of the participants had cirrhosis at enrollment. The majority (98%; 78/80) of the children who received glecaprevir/pibrentasvir were treatment naive; a single participant was HIV/HCV coinfecting. The overall SVR12 with the optimal drug dosages/ratios was 96%. Of the 2 nonresponders, 1 child discontinued treatment after only 1 dose because of palatability and the other after 4 days due to a drug-related rash. No clinically significant laboratory abnormalities or liver-related toxicities were observed ([Jonas, 2021](#)). This regimen was approved for use in children 3 to < 12 years of age in 2021.

Given its pangenotypic activity, safety, and efficacy record in adult patients, glecaprevir/pibrentasvir is recommended as a first choice for pediatric and adolescent HCV treatment. As in adults, coadministration of carbamazepine, efavirenz-containing regimens, and St. John's wort is not recommended since these compounds may decrease concentrations of glecaprevir and pibrentasvir.

## Sofosbuvir/Velpatasvir

The efficacy of sofosbuvir/velpatasvir once daily for 12 weeks was evaluated in an open-label trial among 173 pediatric participants aged  $\geq 6$  years with genotype 1, 2, 3, 4, or 6 infection, without cirrhosis or with compensated cirrhosis. Eighty-five percent of participants (147/173) were treatment naive and 15% (26/173) were treatment experienced. Overall SVR12 was  $\geq 92\%$  across genotypes ([Jonas, 2019a](#)).

Among 102 adolescents aged 12 to  $<18$  years, 78% ( $n=80$ ) were treatment naive and 22% ( $n=22$ ) were treatment experienced. The median age was 15 years (range 12 to 17 years); 51% were female. The genotype distribution among the participants was 74% genotype 1, 6% genotype 2, 12% genotype 3, 2% genotype 4, and 6% genotype 6. No adolescents had known cirrhosis. The majority (89%; 91/102) had been infected through vertical transmission. SVR12 rates were 93% in adolescents with genotype 1, 91% in those with genotype 3, and 100% in participants with genotype 2, 4, or 6. One participant discontinued treatment at week 4 and subsequently relapsed. The other 4 participants who did not achieve SVR12 did not meet virologic failure criteria (lost to follow-up).

Among 71 children aged 6 to  $<12$  years, the genotype distribution was 76% genotype 1, 3% genotype 2, 15% genotype 3, and 6% genotype 4. None of the participants had known cirrhosis. Ninety-four percent ( $n=67$ ) were treatment naive and 6% ( $n=4$ ) were treatment experienced. The median age was 8 years (range 6 to 11 years); 54% were female. The majority of children (94%; 67/71) had been infected through vertical transmission. SVR12 rates were 93% (50/54) in children with genotype 1, 91% (10/11) in those with genotype 3, and 100% in participants with genotype 2 (2/2) or genotype 4 (4/4). One participant had on-treatment virologic failure; the other 4 participants who did not achieve SVR12 did not meet virologic failure criteria (lost to follow-up).

Sofosbuvir/velpatasvir was approved by the FDA for pediatric patients aged  $\geq 6$  years in March 2020 and for children 3 to  $< 6$  years of age in June 2021. Given its pangenotypic activity, safety, and efficacy, sofosbuvir/velpatasvir is recommended as a first choice for HCV treatment in children and adolescents. Due to reports from experience among adults, coadministration of sofosbuvir/velpatasvir with amiodarone is not recommended due to the risk for symptomatic bradycardia.

## Ledipasvir/Sofosbuvir

Ledipasvir/sofosbuvir is approved for use in children aged 3 through 17 years with genotype 1, 4, 5, or 6 infection. In a phase 2, multicenter, open-label study of 100 adolescents with genotype 1 treated for 12 weeks with the adult formulation of ledipasvir/sofosbuvir, SVR12 was documented in 98% of participants ([Balistreri, 2017](#)). The 2 patients who did not achieve SVR12 were lost to follow-up during or after treatment. Eighty percent of the patients were treatment naive. One patient had cirrhosis, 42 did not, and the cirrhosis status was unknown in the remaining 57. The regimen was safe and well tolerated in this population, and the adult dosage formulation resulted in pharmacokinetic characteristics similar to those observed in adults. Two clinical trials supporting the approval of ledipasvir/sofosbuvir in the pediatric population aged 3 through 11 years demonstrated high SVR12 rates comparable to those seen in adults ([Schwarz, 2019](#)); ([Murray, 2018](#)). Among children  $<12$  years of age, dosing is weight based (see Table 1). Twelve weeks of ledipasvir/sofosbuvir is recommended for treatment-naive children and adolescents aged  $\geq 3$  years without cirrhosis or with compensated cirrhosis (Child-Pugh A). This regimen is also recommended for interferon-experienced ( $\pm$  ribavirin, with or without an HCV protease inhibitor) children and adolescents aged  $\geq 3$  years with genotype 1 or 4. A 12-week course is recommended for patients without cirrhosis; 24 weeks is recommended for those with compensated cirrhosis.

## Sofosbuvir Plus Ribavirin

In September 2019, the FDA approved weight-based sofosbuvir plus ribavirin (see Table 4) for treatment-naive or

interferon-experienced ( $\pm$  ribavirin) children aged  $\geq 3$  years with genotype 2 or 3, without cirrhosis or with compensated cirrhosis (Child-Pugh A). This regimen is no longer favored because pangenotypic ribavirin-free treatments are now available for children as young as 3 years of age.

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## Related References

- Alter MJ, Kruszon-Moran D, Nainan OV, et al. [The prevalence of hepatitis C virus infection in the United States, 1988 through 1994](#). *N Engl J Med*. 1999;341(8):556-562.
- Aniszewska M, Kowalik-Mikolajewska B, Pokorska-Spiewak M, Marczyńska M. [Anti-HCV testing as a basic standard of monitoring HCV mother-to-child infection: advantages and disadvantages of the method](#). *Przeegl Epidemiol*. 2012;66:341-345.
- Asselah T, Kowdley KV, Zadeikis N, et al. [Efficacy of glecaprevir/pibrentasvir for 8 or 12 weeks in patients with hepatitis C virus genotype 2, 4, 5, or 6 infection without cirrhosis](#). *Clin Gastroenterol Hepatol*. 2018;16(3):417-426.
- Asselah T, Kowdley KV, Zadeikis N, et al. [Efficacy of glecaprevir/pibrentasvir for 8 or 12 weeks in patients with hepatitis C virus genotype 2, 4, 5, or 6 infection without cirrhosis](#). *Clin Gastroenterol Hepatol*. 2018;16(3):417-426.
- Balistreri WF, Murray KF, Rosenthal P, et al. [The safety and effectiveness of ledipasvir-sofosbuvir in adolescents 12-17 years old with hepatitis C virus genotype 1 infection](#). *Hepatology*. 2017;66(2):371-378.
- Behairy B-S, Sira MM, Zalata KR, Salama el-SE, Abd-Allah MA. [Transient elastography compared to liver biopsy and morphometry for predicting fibrosis in pediatric chronic liver disease: Does etiology matter?](#) *World J Gastroenterol*. 2016;22(16):4238-4249.
- Benova L, Mohamoud YA, Calvert C, Abu-Raddad LJ. [Vertical transmission of hepatitis C virus: systematic review and meta-analysis](#). *Clin Infect Dis*. 2014;59(6):765-773.
- Bortolotti F, Verucchi G, Camma C, et al. [Long-term course of chronic hepatitis C in children: from viral clearance to end-stage liver disease](#). *Gastroenterology*. 2008;134:1900-1907.
- Brown RS, Buti M, Rodrigues L, et al. [Efficacy and safety of 8-week glecaprevir/pibrentasvir in treatment-naive patients with chronic hepatitis c virus genotype 1, 2, 3, 4, 5, or 6 infection and compensated cirrhosis: EXPEDITION-8 complete results \[abstract LP9\]](#). Presented at Liver Meeting, 2019; November 8-12. 2019.
- Casiraghi M, Antonietta, De Paschale M, Romanò L, et al. [Long-term outcome \(35 years\) of hepatitis C after acquisition of infection through mini transfusions of blood given at birth](#). *Hepatology*. 2004;39(1):90-96.
- Cottrell E, Chou R, Wasson N, Rahman B, Guise J-M. [Reducing risk for mother-to-infant transmission of hepatitis C virus: a systematic review for the U.S. Preventive Services Task Force](#). *Ann Intern Med*. 2013;158(2):109-113.
- Cua IH, Hui JM, Kench JG, George J. [Genotype-specific interactions of insulin resistance, steatosis, and fibrosis in chronic hepatitis C](#). *Hepatology*. 2008;48:723-731.
- Delotte J, Barjoan E, Berrébi A, et al. [Obstetric management does not influence vertical transmission of HCV infection: results of the ALHICE group study](#). *J Matern Fetal Neonatal Med*. 2014;27(7):664-670.
- England K, Pembrey L, Tovo PA, Newell ML. [Excluding hepatitis C virus \(HCV\) infection by serology in young infants of HCV-infected mothers](#). *Acta Paediatr*. 2005;94:444-450.

- [European paediatric hepatitis C virus network. A significant sex--but not elective cesarean section--effect on mother-to-child transmission of hepatitis C virus infection.](#) *J Infect Dis.* 2005;192(11):1872-1879.
- Farmand S, Wirth S, Loffler H. [Spontaneous clearance of hepatitis C virus in vertically infected children.](#) *Eur J Pediatr.* 2012;171:253-258.
- Forns X, Lee SS, Valdes J, et al. [Glecaprevir plus pibrentasvir for chronic hepatitis C virus genotype 1, 2, 4, 5, or 6 infection in adults with compensated cirrhosis \(EXPEDITION-1\): a single-arm, open-label, multicentre phase 3 trial.](#) *Lancet Infect Dis.* 2017;17(10):1062-1068.
- Garazzino S, Calitri C, Versace A, et al. [Natural history of vertically acquired HCV infection and associated autoimmune phenomena.](#) *Eur J Pediatr.* 2014;173:1025-1031.
- Geng X-X, Huang R-G, Lin J-M, Jiang N, Yang X-X. [Transient elastography in clinical detection of liver cirrhosis: a systematic review and meta-analysis.](#) *Saudi J Gastroenterol.* 2016;22(4):294-303.
- Gonzalez-Peralta RP, Langham MR, Andres JM, et al. [Hepatocellular carcinoma in 2 young adolescents with chronic hepatitis C.](#) *J Pediatr Gastroenterol Nutr.* 2009;48(5):630-635.
- Goodman ZD, Makhlof HR, Liu L, et al. [Pathology of chronic hepatitis C in children: liver biopsy findings in the Peds-C trial.](#) *Hepatology.* 2008;47(3):836-843.
- Gowda C, Smith S, Crim L, Moyer K, Sanchez PJ, . [Nucleic Acid Testing for Diagnosis of Perinatally Acquired Hepatitis C Virus Infection in Early Infancy.](#) *Clin Infect Dis.* 2021;73(9):e3340-e3346. doi:10.1093/cid/ciaa949.
- Gower E, Estes C, Blach S, Razavi-Shearer K, Razavi H. [Global epidemiology and genotype distribution of the hepatitis C virus infection.](#) *J Hepatol.* 2014;61(1 Suppl):S45-S57.
- Greenway E, Haines A, Ling SC, et al. [Cost-utility analysis of treatment of chronic paediatric hepatitis C with new direct-acting antivirals \[abstract 1619\].](#) *The Liver Meeting 2019.* 2019.
- Honegger J, Crim L, Gowda C, Sanchez PJ. [Polymerase chain reaction \(PCR\) for detection of vertically-acquired hepatitis C virus \(HCV\) infection in early infancy \[abstract 2215\].](#) *ID Week.* 2018.
- Indolfi G, Easterbrook P, Dusheiko GM, et al. [Hepatitis C virus infection in children and adolescents.](#) *Lancet Gastroenterol Hepatol.* 2019;4:477-487.
- Jacobson IM, Gordon SC, Kowdley KV, et al. [Sofosbuvir for hepatitis C genotype 2 or 3 in patients without treatment options.](#) *N Engl J Med.* 2013;368:1867-1877.
- Jhaveri R. [Diagnosis and management of hepatitis C virus-infected children.](#) *Pediatr Infect Dis J.* 2011;30(11):983-985.
- Jonas MM, Squires RH, Rhee S, et al. [Pharmacokinetics, safety, and efficacy of glecaprevir/pibrentasvir in adolescents with chronic hepatitis C virus: part 1 of the DORA study.](#) *Hepatology.* 2019:[Epub ahead of print]. doi:10.1002/hep.30840.
- Jonas MM, Romero R, Sokal EM, et al. [Safety and efficacy of sofosbuvir/velpatasvir in pediatric patients 6 to <18 years old with chronic hepatitis C infection \[abstract 748\].](#) *The Liver Meeting.* 2019.
- Jonas MM, Lon HK, Rhee S, et al. [Pharmacokinetics of glecaprevir/pibrentasvir in children with chronic HCV infection: interim analysis of part 2 of the DORA study \[abstract 1551\].](#) *The Liver Meeting. Boston.* 2019.
- Jonas MM, Rhee S, Kelly DA, et al. [Pharmacokinetics, safety, and efficacy of glecaprevir/pibrentasvir in children with chronic hepatitis C virus: part 2 of the DORA study.](#) *Hepatology.* 2021;74(1):19-27. doi:10.1002/hep.31841.
- Kukla M, Piotrowski D, Waluga M, Hartleb M. [Insulin resistance and its consequences in chronic hepatitis C.](#) *Clin Exp*

*Hepatology*. 2015;1(1):17-29.

Lawitz E, Mangia A, Wyles D, et al. [Sofosbuvir for previously untreated chronic hepatitis C infection](#). *N Engl J Med*. 2013;368:1878-1887.

Lee CK, Perez-Atayde AR, Mitchell PD, Raza R, Afdhal NH, Jonas MM. [Serum biomarkers and transient elastography as predictors of advanced liver fibrosis in a United States cohort: the Boston Children's Hospital experience](#). *J Pediatr*. 2013;163(4):1058-1064.e2.

Mack CL, Gonzalez-Peralta RP, Gupta N, et al. [NASPGHAN practice guidelines: diagnosis and management of hepatitis C infection in infants, children, and adolescents](#). *J Pediatr Gastroenterol Nutr*. 2012;54(6):838-855.

Marrero JA, Kulik LM, Sirlin CB. [Diagnosis, staging, and management of hepatocellular carcinoma: 2018 practice guidance by the American Association for the Study of Liver Diseases](#). *Hepatology*. 2018;68(2):723-750.

Mast EE, Hwang L-Y, Seto DSY, et al. [Risk factors for perinatal transmission of hepatitis C virus \(HCV\) and the natural history of HCV infection acquired in infancy](#). *J Infect Dis*. 2005;192(11):1880-1889.

Minola E, Prati D, Suter F, et al. [Age at infection affects the long-term outcome of transfusion-associated chronic hepatitis C](#). *Blood*. 2002;99(12):4588-4591.

Mizuochi T, Takano T, Yanagi T, et al. [Epidemiologic features of 348 children with hepatitis C virus infection over a 30-year period: a nationwide survey in Japan](#). *J Gastroenterol*. 2018;53:419-426.

Moucari R, Asselah T, Cazals-Hatem D, et al. [Insulin resistance in chronic hepatitis C: association with genotypes 1 and 4, serum HCV RNA level, and liver fibrosis](#). *Gastroenterology*. 2008;134:416-423.

Murray KF, Balistreri WF, Bansal S, et al. [Safety and efficacy of ledipasvir-sofosbuvir with or without ribavirin for chronic hepatitis C in children ages 6-11](#). *Hepatology*. 2018;68:2158-2166.

Nguyen J, Barritt AS, Jhaveri R. [Cost effectiveness of early treatment with direct-acting antiviral therapy in adolescent patients with hepatitis C infection](#). *J Pediatr*. 2019;(207):90-96. doi:10.1016/j.jpeds.2018.12.012.

Nielsen J, Christensen VB, Borgwardt L, Rasmussen A, Ostrup O, Kjaer MS. [Prognostic molecular markers in pediatric liver disease - Are there any?](#). *Biochim Biophys Acta Mol Basis Dis*. 2019;(1865):577-586.

Petta S, Camma C, DiMarco V, et al. [Hepatic steatosis and insulin resistance are associated with severe fibrosis in patients with chronic hepatitis caused by HBV or HCV infection](#). *Liver Int*. 2011;31:507-515.

Pokorska-Spiewak M, Kowalik-Mikolajewska B, Aniszewska M, Pluta M, Marczyńska M. [Clinical usefulness of new noninvasive serum biomarkers for the assessment of liver fibrosis and steatosis in children with chronic hepatitis C](#). *Clin Exp Hepatol*. 2017;3:198-202.

Puoti M, Foster GR, Wang S, et al. [High SVR12 with 8-week and 12-week glecaprevir/pibrentasvir therapy: An integrated analysis of HCV genotype 1-6 patients without cirrhosis](#). *J Hepatol*. 2018;69(2):293-300.

Resti M, Jara P, Hierro L, et al. [Clinical features and progression of perinatally acquired hepatitis C virus infection](#). *J Med Virol*. 2003;70:373-377.

Rosenthal P, Schwarz KB, Gonzalez-Peralta RP, et al. [Sofosbuvir and ribavirin therapy for children aged 3 to <12 years with hepatitis C virus genotype 2 or 3 infection](#). *Hepatology*. 2020;71(1):31-43.

Schmidt AJ, Falcato L, Zahno B, et al. [Prevalence of hepatitis C in a Swiss sample of men who have sex with men: whom to screen for HCV infection?](#). *BMC Public Health*. 2014;14(1):3.

- Schwarz KB, Rosenthal P, Murray KF, et al. [Ledipasvir-sofosbuvir for 12 weeks in children 3 to <6 years old with chronic hepatitis C](#). *Hepatology*. 2019;DOI 10.1002/hep.30830 [Epub ahead of print]. doi:10.1002/hep.30830.
- Shebl FM, El-Kamary SS, Saleh D'aA, et al. [Prospective cohort study of mother-to-infant infection and clearance of hepatitis C in rural Egyptian villages](#). Abdel-Hamid M, Mikhail N, Allam A, et al., eds. *J Med Virol*. 2009;81(6):1024-1031.
- Sulkowski MS, Naggie S, Lalezari J, et al. [Sofosbuvir and ribavirin for hepatitis C in patients with HIV coinfection](#). Fessel WJ, Mounzer K, Shuhart M, et al., eds. *JAMA*. 2014;312(4):353-361.
- Tieu HV, Laeyendecker O, Nandi V, et al. [Prevalence and mapping of hepatitis C infections among men who have sex with men in New York City](#). *PLoS One*. 2018;13:e0200269.
- Vaux S, Chevaliez S, Saboni L, et al. [Prevalence of hepatitis C infection, screening and associated factors among men who have sex with men attending gay venues: a cross-sectional survey \(PREVAGAY\), France, 2015](#). *BMC Infect Dis*. 2019;19:315.
- Wirth S, Rosenthal P, Gonzalez-Peralta RP, et al. [Sofosbuvir and ribavirin in adolescents 12-17 years old with hepatitis C virus genotype 2 or 3 infection](#). *Hepatology*. 2017;66(4):1102-1110.
- Wyles D, Poordad F, Wang S, et al. [Glecaprevir/pibrentasvir for hepatitis C virus genotype 3 patients with cirrhosis and/or prior treatment experience: a partially randomized phase 3 clinical trial: viral hepatitis](#). *Hepatology*. 2018;67(2):514-523.
- Yeung LT, To T, King SM, Roberts EA. [Spontaneous clearance of childhood hepatitis C virus infection](#). *J Viral Hepat*. 2007;14:797-805.
- Zeuzem S, Dusheiko GM, Salupere R, et al. [Sofosbuvir and ribavirin in HCV genotypes 2 and 3](#). *N Engl J Med*. 2014;370:1993-2001.
- Zeuzem S, Foster GR, Wang S, et al. [Glecaprevir-pibrentasvir for 8 or 12 weeks in HCV genotype 1 or 3 Infection](#). *N Engl J Med*. 2018;378(4):354-369. doi:10.1056/NEJMoa1702417.
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